TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1892

VOL. XXV.

(EIGHTH OF NEW SERIES)

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE

BY

SIR JAMES HECTOR, K.C.M.G., M.D., F.R.S.
DIRECTOR

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CONTENTS.

TRANSACTIONS.

I.—ZOOLOGY.

NEW ZEALAND INSTITUTE.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

AUCKLAND INSTITUTE.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OTAGO INSTITUTE.

WESTLAND INSTITUTE.

APPENDIX.

LIST OF PLATES.

NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

Board of Governors.

(EX OFFICIO.)

His Excellency the Governor.
The Hon. the Colonial Secretary.

(NOMINATED.)

The Hon. W. B. D. Mantell, F.G.S.; W. T. L. Travers, F.L.S.; Sir James Hector, K.C.M.G., M.D., F.R.S.; W. M. Maskell, F.R.M.S.; Thomas Mason; E. Tregear, F.R.G.S.

(ELECTED.)

1892.—James McKerrow, F.R.A.S.; S. Percy Smith, F.R.G.S.; Sir Walter Buller, K.C.M.G., F.R.S.

Manager: Sir James Hector.

Honorary Treasurer: W. T. L. Travers, F.L.S.

Secretary: R. B. Gore.

ABSTRACTS OF RULES AND STATUTES.

Gazetted in the "New Zealand Gazette," 9th March, 1868.

Section I.

Incorporation of Societies.

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for

which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £50.

3. The by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of the annual revenue in or towards the formation or support of some local public museum or library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and library of the New Zealand Institute.

4. Any society incorporated as aforesaid, which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and may then be published as Proceedings or Transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:—

Regulations regarding Publications.

(*a.*) The publications of the Institute shall consist of a current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute," and of transactions, comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), to be intituled "Transactions of the New Zealand Institute."

(*b.*) The Institute shall have power to reject any papers read before any of the incorporated societies.

(*c.*) Papers so rejected will be returned to the society in which they were read.

(*d.*) A proportional contribution may be required from each society towards the cost of publishing the Proceedings and Transactions of the Institute.

(*e.*) Each incorporated society will be entitled to receive a *proportional* number of copies of the Proceedings and Transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f.*) Extra copies will be issued to any of the members of incorporated societies at the cost-price of publication.

6. All property accumulated by or with funds derived from incorporated societies, and placed in charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the by-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the society.

Section II.

For the Management of the Property of the Institute.

9. All donations by societies, public departments, or private individuals to the Museum of the Institute shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal, to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to natural science may be deposited in the library of the Institute, subject to the following conditions:—

(*a.*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b.*) Any funds especially expended on binding and preserving such deposited books at the request of the depositor shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c.*) No books deposited in the library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and library, subject to by-laws to be framed by the Board.

Section III.

The laboratory shall for the time being be and remain under the exclusive management of the Manager of the Institute.

Section IV.

(Of Date 23rd September, 1870.)

Honorary Members.

Whereas the rules of the societies incorporated under the New Zealand Institute Act provide for the election of honorary members of such societies, but inasmuch as such honorary members would not thereby become members of the New Zealand Institute, and whereas it is expedient to make provision for the election of honorary members of the New Zealand Institute, it is hereby declared,—

1. Each incorporated society may, in the month of November next, nominate for election, as honorary members of the New Zealand Institute, three persons, and in the month of November in each succeeding year one person, not residing in the colony.
2. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.
3. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be honorary members of the New Zealand Institute, provided that the total number of honorary members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd Oct., 1868.
Otago Institute	18th Oct., 1869.
Westland Institute	21st Dec., 1874.
Hawke's Bay Philosophical Institute	31st Mar., 1875.
Southland Institute	21st July, 1880.
Nelson Philosophical Society	20th Dec., 1883.

OFFICERS OF INCORPORATED SOCIETIES, AND EXTRACTS FROM THE RULES.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1893.—*President*—Major-General Schaw, C.B., R.E.; *Vice-presidents*—G. V. Hudson, F.E.S., S. Percy Smith, F.R.G.S.; *Council*—C. Hulke, F.C.S., W. M. Maskell, F.R.M.S., Sir James Hector, K.C.M.G., F.R.S., E. Tregear, F.R.G.S., G. Denton, R. C. Harding, W. T. L. Travers, F.L.S.; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1893.—*President*—Professor Pond; *Vice-presidents*—Professor F. D. Brown, F.C.S., J. Stewart, C.E.; *Council*—W. Berry, C. Cooper, G. Mueller, T. Peacock, J. A. Pond, F.C.S., Rev. A. G. Purchas, M.R.C.S.E., E.

Roberton, M.D., T. H. Smith, Professor A. P. W. Thomas, F.L.S., J. H. Upton, E. Withy; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S., F.R.S.; *Auditor*—W. Gorrie.

Extracts from the Rules of the Auckland Institute.

1. Any person desiring to become a member of the Institute shall be proposed in writing by two members, and shall be balloted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance-fee, in addition to the annual subscription of one guinea, the annual subscription being payable in advance on the first day of April for the then current year.

5. Members may at any time become life-members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual general meeting of the society on the third Monday of February in each year. Ordinary business meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OFFICE-BEARERS FOR 1893.—*President*—Professor A. W. Bickerton, F.C.S.; *Vice-presidents*—R. M. Laing, B.Sc., Dr. Thomas; *Secretary*—B. Bull, B.Sc.; *Treasurer*—J. T. Meeson, B.A.; *Council*—R. W. Fereday, F. Barkas, S. Page, R. Speight, B.Sc., W. H. Symes, M.D., H. R. Webb, F.R.M.S.

Extracts from the Rules of the Philosophical Institute of Canterbury.

21. The ordinary meetings of the Institute shall be held on the first Thursday of each month during the months from March to November inclusive.

35. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the first of November in every year.

37. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

OTAGO INSTITUTE.

OFFICE-BEARERS FOR 1893.—*President*—Dr. T. M. Hocken; *Vice-presidents*—C. W. Adams, E. Melland; *Treasurer*—Professor F. B. de M. Gibbons; *Secretary*—A. Hamilton; *Auditor*—D. Brent; *Council*—Rev. Dr. Belcher, Professor Scott, Professor Parker, G. M. Thomson, F. R. Chapman, D. Wilkinson, and G. A. Simmers.

Extracts from the Constitution and Rules of the Otago Institute.

2. Any person desiring to join the society may be elected by ballot, on being proposed in writing at any meeting of the Council or society by two members, and on payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life-members by one payment of ten pounds and ten shillings in lieu of future annual subscriptions.

8. An annual general meeting of the members of the society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

WESTLAND INSTITUTE.

Office-bearers for 1893.—*President*—W. C. Fendall; *Vice-president*—A. H. King; *Hon. Treasurer*—H. L. Michel; *Committee*—Rev. J. Blackburne, Captain Bignell, Messrs. J. Churches, W. L. Fowler, T. H. Gill, Dr. Macandrew, A. Mahan, R. Ross, J. N. Smythe, J. Strauchon, R. W. Wade, and D. Macfarlane.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist (1) of life-members—*i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards, or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting; (2) of members who pay two pounds two shillings each year; (3) of members paying smaller sums, not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1893.—*President*—Dr. Moore; *Vice-president*—Thomas Humphries; *Hon. Secretary*—W. Dinwiddie; *Hon. Treasurer*—J. S. Large; *Auditor*—T. K. Newton; *Council*—Miss Browning, J. W. Carlile, M.A., J. W. Craig, H. Hill, B.A., F.G.S., H. H. Pinckney, B.A., J. Ringland.

Extracts from the Rules of the Hawke's Bay Philosophical Institute.

3. The annual subscription for each member shall be one guinea, payable in advance on the first day of January in every year.

4. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke's Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

SOUTHLAND INSTITUTE.

Office-bearers for 1893.—*Trustees*—Ven. Archdeacon Stocker, Rev. John Ferguson, Dr. James Galbraith.

NELSON PHILOSOPHICAL SOCIETY.

Office-bearers for 1893.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson and Dr. L. Boor; *Hon. Secretary*—Sidney Black; *Hon. Treasurer*—Dr. James Hudson; *Hon. Curator of the Museum*—R. I. Kingsley; *Hon. Custodian of the School of Mines*—Mr. Worley; *Council*—Dr. W. Mackie, Dr. G. H. Cressy, Messrs. J. Holloway, Kingsley, and Worley.

Extracts from the Rules of the Nelson Philosophical Society.

4. That members shall be elected by ballot.

6. That the annual subscription shall be one guinea.

7. That the sum of ten guineas may be paid in composition of the annual subscription.

16. That the meetings be held monthly.

23. The papers read before the Society shall be immediately delivered to the Secretary.

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1892.

I.—ZOOLOGY.

Art. I.—*On the Classification and Mutual Relations of the* Dinornithidæ.

By Professor T. Jeffery Parker, F.R.S.

[*Read before the Otago Institute, 10th May, 1892.*]

A detailed study of the skull of the moas has led me to adopt views as to the classification and mutual relationships of these birds which do not agree with those expressed by Professsor Hutton in his recent admirable paper.* The full account of my observations will be published elsewhere, but a brief account of the conclusions at which I have arrived may be of interest.

Hutton is probably right in assigning the broad-beaked skull usually assigned to the species *crassus* to *elephantopus*; in considering *parvus* as a variety of *didiformis*; and probably also in assigning the large, narrow-beaked skull, usually called *elephantopus*, to *crassus*. On the other hand, I consider *didinus* to be merely a small variety of *casuarinus*.

Assuming these determinations to be correct, I admit the following genera:—

1. *Dinornis*, including the species *giganteus*, *maximus*, *ingens*, &c.
2. *Emeus*, including the species *crassus*.
3. *Mesopteryx*, including the species *casuarina*, and probably *geranoides*.

* "The Moas of New Zealand," Trans. N.Z. Inst., vol. xxiv. (1891), p. 93.

4. *Anomalopteryx*, including the species *didiformis* and *curta*.
5. *Pachyornis*, including the species *gravis*, *ponderosus*, and *elephantopus*.

The retention of the genera *Palapteryx* and *Cela* does not appear to me to be warranted by the facts.

Dinornis and *Pachyornis* have broad beaks; *Emeus*, *Mesopteryx*, and *Anomalypteryx* narrow, more or less pointed beaks; and as these differences are correlated with well-marked and definable characters in the cranium, maxillo-jugal arch, and mandible, they allow of the separation of the moas into three sub-families: one containing the tall, slender, flat-skulled, broad-beaked *Dinornis*; another the small or moderate-sized, narrow-beaked *Emeus*, *Mesopteryx*, and *Anomalopteryx*; and the third the squat, thick-limbed, broad-beaked *Pachyornis*.

Expressed in a tabulated form the proposed classification is as follows:—

Family—DINORNITHIDÆ.
  Sub-family I. *Gigantornithinæ*.
    Genus 1. *Dinornis*, Owen.
      Species—*giganteus*, *maximus*, *robustus*, *ingens*, *torosus*, *struthioides*, &c.
  Sub-family II. *Mesornithinæ*.
    Genus 2. *Emeus*, Reichenbach.
      Species—*crassus*, an undetermined skull called provisionally species *a*.
    Genus 3. *Mesopteryx*, Hutton.
      Species—*casuarina* (including *didina*), three undetermined skulls called provisionally species *a*, *b*, and *c*.
    Genus 4. *Anomalopteryx*, Reichenbach.
      Species—*didiformis* (including *parva*), ? *curta* (including *oweni*).
  Sub-family III. *Pachyornithinæ*.
    Genus 5. *Pachyornis*, Lydekker.
      Species—*gravis*, *ponderosus*, *elephantopus*, an undetermined skull called provisionally species *a*.

As to the mutual relations of the various forms, *Mesopteryx* appears to be the most generalized genus, and to show most nearly the ancestral characters of the family. *Emeus* may be looked upon as a large and muscular development of the *Mesopteryx* stock. *Anomalopteryx* may be considered as having arisen from a common ancestor with *Mesopteryx*, but to have undergone specialisation in certain directions, the straight beak and immense temporal fovea being two very striking peculiarities. *Pachyornis* is probably to be derived from the *Mesopteryx* stock, but shows great specialisation in its broad beak

Postscript to Professor Parker's Paper on the Classification, &c., of the Dinornithidæ.

Since writing this paper I find that further researches have convinced Professor Hutton that he was not justified in definitely assigning a narrow-beaked skull to *Emeus* and a broad-beaked skull to *Pachyornis*. I have therefore come to the conclusion that, for the present at any rate, it will cause least confusion to follow Owen and Lydekker in this matter. Thus, in my forthcoming monograph to be published in the Transactions of the Zoological Society (see abstract in Proceedings Zool. Soc., 14th February, 1893), the large narrow-beaked skull called in the present paper *Emeus crassus* is named, as by Owen and Lydekker, *Pachyornis elephantopus*, and the broad-beaked skulls here assigned to *Pachyornis* are referred to *Emeus*. Thus the names *Emeus* and *Pachyornis*, as used in this paper, must be transposed.

I have also found, from a conversation with Professor A. Newton, at Cambridge, that the names I assigned in the present paper to the sub-families are not in accordance with the rules of zoological nomenclature. The classification adopted in my large paper is therefore as follows:—

Sub-family *a. Dinornithinæ.*
  Genus *Dinornis.*
Sub-family *b. Anomalopteryginæ.*
  Genera *Pachyornis, Mesopteryx, Anomalopteryx.*
Sub-family *c. Emeinæ.*
  Genus *Emeus.*

April, 1893.

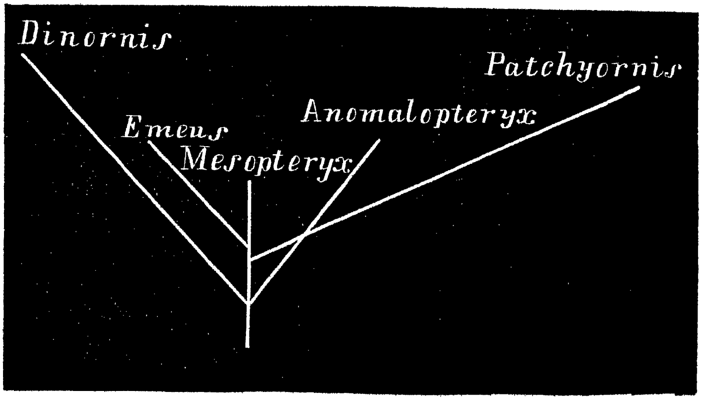
Postscript to Professor Parker's Paper on the Presence of a Crest in some of the Moas.

During my recent visit to England I have examined the moa-remains in all the principal museums, and have found feather-pits in two specimens of *Dinornis robustus*—viz., the magnificent individual skeleton from Tiger Hill, Manuherikia, in the Museum of the Philosophical Society, York, and a skeleton from Glenmark Swamp in the Tasmanian Museum, Hobart. The fact that some specimens both of *robustus* and of *ingens (torosus)* have the pits, while there is no trace of them in others, certainly points to the crest being a sexual character.

April, 1893.

distinct maxillo-nasal bone, absence of an antrum or cavity in the maxillo-palatine, and by the strong, coarse character of the bones in general. *Dinornis* is in some respects even more specialised than *Pachyornis*, but in an opposite direction: as regards the skeleton generally, it runs to height rather than thickness, and its skull is remarkable for its great breadth and flatness, and for the long, broad, deflected beak.

The following phylogenetic diagram gives the views at which I have arrived on this subject:—



ART. II.—*On the Presence of a Crest of Feathers in certain Species of Moa.*

By Professor T. JEFFERY PARKER, F.R.S.

[*Read before the Otago Institute, 10th May, 1892.*]

Plates I.–III.

ANY evidence as to the external characters of the moa is of interest. We know the general structure of the feathers, and of the thickened and scaly skin covering the feet, but hitherto the only direct evidence as to the appearance of the entire head is furnished by the magnificent specimen of *Mesopteryx casuarina* (*Dinornis didinus*, Owen) obtained near Queenstown in 1878, and forwarded to the British Museum in 1882 by Mr. H. L. Squires.* The specimen is covered with dried

* Sir R. Owen states that the discovery of this specimen was first noticed in the "'*Tuatara Times*,' published at Otago in November, 1878." The real name of this paper is the *Tuapeka Times*. The notice is quoted, as I am informed by Mr. A. Hamilton, in the *Otago Daily Times* of the 27th November. 1878.

skin on which no feathers are retained, but, as Sir R. Owen says,* "their pits of insertion are manifest, slightly increasing in size towards the occiput and upon the cervical integument, where the pits become prominent." This, of course, indicates that in the species under discussion the feathers on the head were quite small.

Through the kindness of Sir James Hector I have lately had the opportunity of examining an almost perfect moa's skull in the Colonial Museum, Wellington. It was found in 1879 by Mr. A. McKay,† on the Salisbury Table-land, Nelson, in association with the neck, and in my forthcoming paper on the skull of the *Dinornithidæ* is referred to as *Mesopteryx*, species *b*.

On the anterior region of the skull-roof in this specimen (Pl. I.) are numerous small shallow pits, from one to two millimetres in diameter. They are arranged in two symmetrical groups, a median space about 20mm. long by 15mm. in diameter being entirely free from them: the two groups are, however, connected immediately posterior to this bare area by a narrow band of small and shallow pits. They are absent on the supra-orbital ridge and on the pre-orbital process (lacrymal). The hinder boundary of the entire pitted area is a line joining the posterior borders of the post-orbital processes, its anterior boundary a line joining the posterior edges of the pre-orbital processes. On the right side the arrangement of the pits is quite irregular, but on the left they are arranged in more or less regular lines radiating from the curved posterior border of the pre-maxillary groove or depressed area on the nasals for the reception of the nasal process of the pre-maxilla.

In the skull of the type specimen of *Dinornis torosus*, Hutton, kindly lent to me by Mr. R. I. Kingsley, a similar pitted area is seen. There is, however, no bare space behind the pre-maxillary groove, and the pits extend forwards, on each side of the pre-maxillary groove, onto the exposed portions of the nasals, and are also continued onto the pre-orbital processes (lacrymals). Moreover, while very faint markings can be seen as far back as the posterior edge of the post-orbital process, the distinct, well-marked pits reach only as far back as its anterior border. As in *Mesopteryx*, species *b*, they are arranged in fairly-distinct radiating lines, and those in the middle—*i.e.*, immediately posterior to the pre-maxillary groove—are much smaller than the rest.

In two skulls of *Anomalopteryx didiformis*, Owen, belonging to Mr. A. Hamilton, there are paired pitted areas, similar

* "On Dinornis," Part 24, Trans. Zool. Soc., vol. xi., p. 257

† "Reports of Geological Explorations" (N.Z.), 1878–79, p. 131.

to but smaller and less distinct than those of *Mesopteryx*, species *b*, only reaching as far back as the anterior border of the post-orbital process, and not extending on to the lacrymal.

Another skull of *Anomalopteryx didiformis* in Mr. Hamilton's collection has no trace of the pits; they are also absent in a skull in the Otago University Museum probably referable to *D. torosus;* and I have failed to find any trace of them in the following species: *Dinornis robustus*, Owen; *Emeus crassus*, Owen; *Mesopteryx casuarina*, Owen; two undetermined species of *Mesopteryx*, one of which may be *M. geranoides*, Owen; *Pachyornis ponderosus*, Hutton; *Pachyornis elephantopus*, Owen, and an undetermined species of the same genus.

I think there can be no doubt that the presence of these pits indicates that the moas in which they occur possessed a crest of stiff feathers in the anterior frontal region. For some time after coming to this conclusion I was unable to support it by the analogy of any other bird: in most cases where a distinct crest of feathers occurs it is situated in the occipital region, over the neck muscles, so that the feathers leave no impression on the skull. But Mr. Hamilton drew my attention to the fact that the skull of the green woodpecker (*Picus viridis*) is pitted in a very similar manner to the moas just described. On laying back the skin of the head in a stuffed specimen of this bird I found that the skull presented paired areas of shallow pits extending over the whole frontal region, and corresponding with the bases of the stiff red feathers of the crest which project through the skin. Similar pits occur on the ulna of *Eudyptes*, the wing-feathers of which are not large enough to give rise to the distinct elevations of bone found in birds with functional remiges. This evidence seems to show that a subcutaneous bone acquires feather-pits when the overlying feathers are larger and stiffer than the ordinary contour-feathers, but not large enough to be called quills.

The fact that certain individuals of a given species have a crest, while others show no indication of that structure, may perhaps be explained by supposing that the male alone was crested.

The following extract seems to show that the Maoris had a tradition assigning a crest to the moa. Dr. G. A. Mantell, in his "Petrifactions and their Teachings," says, on the authority of his son, the Hon. Walter Mantell, that the natives "stated that its head and tail were adorned with plumes of magnificent feathers, which were worn and much prized by their ancient chiefs as ornaments of distinction."*

* Trans. N.Z. Inst., vol. iv., p. 74.

DESCRIPTION OF PLATES I.–III.

[NOTE.—I am indebted to Mr. John Thomson, B.E., Lecturer on Applied Mechanics in the University, for the photograph from which the plates are taken.]

Plate I. Dorsal view of the skull of *Mesopteryx*, species *b*. (Colonial Museum, Wellington.)

Plate II. Dorsal view of the cranium of *Dinornis torosus*, Hutton. (Mr. R. I. Kingsley's collection, Nelson.)

Plate III. Dorsal view of the skull of *Anomalopteryx didiformis*, Owen. (Mr. A. Hamilton's collection, Dunedin.)

[NOTE.—Professor Parker, writing to Mr. Hamilton from York, in January, 1893, reports that the famous moa in the York Museum "has got splendid feather-pits on the skull."—ED.]

ART. III.—*New Species of Moas.*

By Captain F. W. HUTTON, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1892.*]

SINCE I wrote my paper on "The Moas of New Zealand," which I read to the Institute last year, I have seen Mr. R. Lydekker's valuable Catalogue of the Fossil Birds in the British Museum, and I have also been able to study the whole of the magnificent collection of moa bones in the Canterbury Museum, of which I had formerly seen only a portion. This collection was commenced in 1866 by Sir J. von Haast with bones from Glenmark, and he afterwards added others, principally from Shag Point and Whangarei. Last year, when Mr. H. O. Forbes was curator, he secured the collection found at Enfield, near Oamaru, and gave the greater part of it to the Museum. Mr. A. Hamilton has also contributed a good collection from the Te Aute Swamp; and during this year a small number of bones from Hamilton and other places have been obtained by exchange. I am far from having finished my examination of this collection, but, as it has become my duty to arrange and name it, I think it will be advisable to publish at once the changes to which I have been led in my views on the classification of the moas, as well as to give descriptions of five new species which I think it necessary to make. I have also thought that it would be useful to others if I published the average dimensions of the leg-bones of the moas found at Enfield.

There is in the Museum an imperfect skeleton of an individual bird the metatarsus of which is similar to the larger of the two described by Sir R. Owen as *D. elephantopus;* but the skull has a pointed beak, and the vertebræ are of a dif-

ferent type from those found at the sandhills at the mouth of the Shag River associated with skulls with rounded beaks. This larger species of *elephantopus* forms the type of Lydekker's genus *Pachyornis*, and the genus *Euryapteryx* will contain only the blunt-beaked species *E. ponderosa* and *E. gravis*. I find also from the Shag Point collection that the sternum of *Euryapteryx* resembles that of *Mesopteryx* (or *Syornis*), but is more robust and has no pneumatic depressions at the inner anterior corners.

An examination of the collection from Enfield has shown me that *rheïdes* and *casuarina* are congeneric with *didina*, and will all come into the genus *Mesopteryx*, distinguished by its slender pointed beak and shallow temporal fossæ. This leaves *crassus* isolated; and, for the present, it must take Reichenbach's generic name of *Emeus*. The skeleton of *Emeus* is, however, very imperfectly known. A skull from Enfield, which I refer to it, comes near *Mesopteryx*, but has narrower and deeper temporal fossæ. The sternum which I refer provisionally to *Emeus* resembles that of *Euryapteryx*, but has slight pneumatic depressions. In fact, *Emeus* appears to be intermediate between *Mesopteryx* and *Euryapteryx*, and further information is necessary before we can say whether it should be joined to either of them.

It may be thought by some that too many species of moas have already been made; but with this I cannot agree. The study of individual skeletons has shown me that bones, which I formerly regarded as being merely varieties of one species, belong really to different genera; and the more I study the moas the more I see the necessity of limiting the amount of variation allowed to each species. An important biological problem, perhaps not found elsewhere, is presented to us in the development of the moas. This is the variation of an herbivorous race of animals, well supplied with food, and without the check due to the presence of carnivorous mammals preying on them. This problem can only be attacked by studying closely the distribution of the moas both in time and in space; and to do so it is necessary that the species should be closely defined. Again, the relative ages of our Pliocene and Pleistocene terrestrial deposits can probably only be ascertained by the help of moa bones, and here, again, unless the different species and varieties are kept separate, we can never obtain the data necessary to settle these questions.

It may, however, be said, Why give them all names? Why not consider them as varieties of a few species? The answer is that there is still plenty of room for varieties within the limits of these species. For example, individuals of *Dinornis robustus* and *D. strenuus* from Enfield are larger than those from Hamilton. The specimens of *D. torosus* from Enfield

have the metatarsus more robust and its trochleæ more expanded than those from Glenmark. The representatives of *Mesopteryx casuarina* at Enfield have the tibia about 17·5in. long, while in those from Hamilton it averages 18·25in. These instances are sufficient to show that the species are not more restricted than is necessary for convenience of description. If they were made larger we must either use a cumbersome system of sub-varieties; or else, by clubbing varieties together, lose all chance of solving our problems. No one, I presume, at the present day would refuse to recognise two species because intermediate links had been found. This is a pre-Darwinian idea, which means that before a group of individuals may be allowed to form a distinct species all the steps of the ladder on which it rose must be destroyed. This would be a very hard rule for the palæontologist to obey, for he would have to examine and classify the mutations by which one species changed into another without being allowed to give distinct names to any of them.

The difficulties involved in making a correct classification of the moas are due partly to the gradation of characters during the long interval between the earliest and latest forms known: partly to their extraordinary number, through which bones belonging to some three or four genera and ten or twelve species are usually found mixed together: and partly to collectors who either do not preserve intact individual skeletons or, what is much worse, add a bone or two to make a skeleton more complete. These difficulties are so great that the task of straightening things out appears almost hopeless. Nevertheless they must be faced if the problems I have mentioned are to be solved; and we can only hope that by constantly correcting our mistakes they may in time gradually disappear, and we shall then be able to write the remarkable history of the development of the moas in New Zealand in considerable detail, and with considerable confidence that we are giving a fairly-true representation of what really took place.

Descriptions of New Species.

Dinornis strenuus.

This species contains all the birds from the South Island which have, up to now, been included in *D. struthioides*. I formerly thought that the differences between the birds of the two Islands were not sufficient to separate them; but I find that those from the South Island have constantly the metatarsus more robust, and with more widely diverging trochleæ than those from the North Island. In *D. strenuus* also the tibia is rather shorter and more robust than in *D. struthioides*. These differences—which will be seen in the following table—when combined with a difference in geo-

graphical distribution, are, I think, sufficient to constitute distinct species.

—	Length.	Proximal Width.	Width of Shaft.	Distal Width.
		METATARSUS.		
D. struthioides	11·5	3·0	1·5	3·8
D. strenuus	11·1	3·4	1·6	4.6
		TIBIA.		
D. struthioides	23·0	5·3	1·6	3·0
D. strenuus	22·0	5·3	1·7	3·1
		FEMUR.		
D. struthioides	11·0	4·0	1·7	4·4
D. strenuus	10·5	3·5	1·7	4·1

At Enfield most of the metatarsi had a length of about 11·75in. (298mm.), but one pair measured only 11·0in. (289mm.), with the shaft as broad as in the larger birds. This small individual may perhaps have been of the opposite sex to the larger individuals; but intermediate sizes were found, both at Hamilton's and Glenmark.

The average dimensions of the bones obtained at Enfield will be found in the table at the end of the paper.

Anomalopteryx fortis.

The bones on which I found this species are three metatarsi, a tibia, and three imperfect femora from Glenmark. The *metatarsus* has a length from 8·3in. to 7·8in. (208mm. to 198mm.: width at the proximal end, 2·7in. to 2·4in. (68mm. to 61mm.); at the middle of the shaft, 1·5in. (38mm.); and at the distal end, 3·6in. to 3·3in. (91mm. to 84mm.). It is remarkable for the shaft not tapering downwards; for the slight expansion of the proximal end; and for the existence of a considerable depression on the anterior surface of the middle trochlea near its base. The intercondylar ridge is high and the depressions nearly equal in depth; the inner margin of the entocondylar depression is flat and without a median ridge; the hypotarsal ridges (talon) are subequal. The trochleæ resemble those of *A. didiformis*, but the intertrochlear gorges are still more expanded at the bottom. These metatarsi are easily distinguished from those of *Mesopteryx casuarina* by the slightly-expanded proximal end, and by the remarkable depression on the anterior face of the middle trochlea. In both these points they resemble the metatarsi of *A. didiformis;* but in that species the depression is not nearly so well marked and the metatarsi are much smaller.

The *tibia* has a length of 17·5in. (445mm.); the proximal width is 4·6in. (117mm.); width of the shaft, 1·4in. (36mm.); and distal width, 2·1in. (53mm.). The antero-external surface is slightly rounded. The distal end of the specimen is unfortunately partly destroyed, but it shows the extremity to be less expanded than in *M. casuarina*. From the tibia of *Megalapteryx* the present tibia differs in being more expanded at the proximal end.

The *femur* has an average length of 9·8in. (249mm.); the proximal width is 3·3in. (84mm.); the width of the shaft is 1·4in. (35mm.); and the distal width, 3·5in. (89mm.). The popliteal area is but slightly depressed and not well marked off, by which character it can be distinguished from the femur of *Palapteryx plena*. The head rises slowly; the linea aspera is fairly well marked, but there is a smooth space between the rough tubercle below the nutrient canal and that on the inner side of the popliteal area. This character distinguishes it from the femora of *Mesopteryx*, *Palapteryx*, and *Megalapteryx*; the popliteal area is also shorter than in *Megalapteryx*. The shaft is more curved anteriorly than in *A. didiformis*, but less so than in *Megalapteryx tenuipes* (Lydekker). From the femur of *M. casuarina* it can also be distinguished by being slighter, by having a shorter head, and by not being so expanded distally.

I append a table of measurements in which are included the leg-bones of an individual skeleton of *A. parva*, from a cave at Highfield, near Waiau. It will be seen that this specimen has a longer and more slender femur than *A. didiformis*, the dimensions of which are taken entirely from North Island birds. This, however, seems hardly sufficient to entitle it to rank as a separate species.

—	Length.	Proximal Width.	Width of Shaft.	Distal Width.
		METATARSUS.		
A. fortis	8·0	2·5	1·5	3·5
A. didiformis	6·3	2·1	1·2	2·8
A. parva	6·3	2·0	1·2	2·6
		TIBIA.		
A. fortis	17·5	4·6	1·4	2·1
A. didiformis	13·3	3·3	1·1	1·8
A. parva	13·7	3·5	1·2	1·8
		FEMUR.		
A. fortis	9·8	3·3	1·4	3·5
A. didiformis	8·0	3·0	1·3	3·2
A. parva	8·5	2·8	1·1	3·0

Euryapteryx compacta.

This species is founded on a tibia from Enfield which closely resembles that of *E. gravis*, but is much smaller. From the tibia of *M. didina* it is distinguished by its greater robustness, and its greater width at the distal extremity. The distal extremity is, however, not expanded inwards as in *Pachyornis*, which at once distinguishes this tibia from that of *P. pygmæus*. Length, 15·2in. (386mm.); proximal width, 4·6in. (117mm.); width at middle of shaft, 1·6in. (39mm.); at distal end, 2·4in. (61mm.).

The metatarsus which I place with this tibia much resembles that of *P. pygmæus*, but has the trochleæ considerably more expanded. Its length is 7·2in. (183mm.); the proximal width, 2·8in. (71mm.); middle of shaft, 1·6in. (41mm.); and distal width, 3·4in. (86mm.). The femur, which I have added with great hesitation, resembles that of *M. didina*, but has a larger head. Length, 9·1in. (231mm.); proximal width, 3·5in. (89mm.); width at middle, 1·4in. (36mm.); distal width, 3·6in. (91mm.). The association of these bones with the tibia is provisional only until further information is obtained; but the tibia cannot be placed in any previously-described species.

Pachyornis inhabilis.

This species is founded on an incomplete individual skeleton in the Canterbury Museum, the exact locality of which is not known, but probably it was found somewhere in Canterbury. It consists of the leg-bones, fifteen phalanges, a fragment of the pelvis, and six vertebræ.

The *metatarsus* has a length of 8·5in. (216mm.); the proximal width is 3·8in. (96mm.); width of the shaft, 2·0in. (51mm.); and distal width, 4·5in. (114mm.). The inner margin of the entocondylar depression has no median ridge, and the hypotarsal ridges (talon) are equal. The bone much resembles the metatarsus of *Euryapteryx ponderosa*, but is not so robust; also the posterior surface of the middle trochlea rises abruptly from the shaft, and nearly at right angles with it, while in *E. ponderosa* it is very oblique, and merges more or less gradually into the shaft. From the metatarsus of *E. gravis* the present species can be recognised by being more expanded proximally.

The *tibia* has a length of about 19·5in. (495mm.); the width of the shaft is 1·8in. (46mm.); and the distal width, 3·3in. (84mm.). It has the great inward expansion at the distal end, which is one of the characters of *Pachyornis*, and which distinguishes that genus from *Euryapteryx*.

The femur has a length of about 11·5in. (292mm.); the proximal width is 4·5in. (114mm.); the width of the shaft, 2·0in. (51mm.); and the distal width is 5·0in. (127mm.). The

popliteal area is very broad, as in *Pachyornis elephantopus* and *E. ponderosa*, but it differs from both in not having the rough line along the inner side of the popliteal area broken by a smooth groove; the head also does not rise so rapidly as in either of those species.

The vertebræ show considerable differences from those of *P. elephantopus*, especially in the centra of the cervicals being more compressed. These differences may be, perhaps, of generic value; but, until the skull is known with certainty, it is better to keep it, as well as the next species, in *Pachyornis*.

This species also occurred at Glenmark and at Hamilton's; but the typical form was not found at Enfield. There were, however, a few specimens of a larger bird which, for the present, I refer to this species, although it may probably be distinct. The metatarsus is 9·5in. and the tibia 20·5in. in length. The other dimensions will be found in the table at the end of the paper.

Pachyornis valgus.

This species is founded on a pair of tibiæ from Enfield, so different from any others in the extraordinary internal expansion of the distal end that I feel compelled to distinguish them under a separate name. The dimensions are as follow: Length, 18·0in. (457mm.); proximal width, 5·7in. (143mm.); width of shaft, 1·7in. (43mm.); distal width, 3·3in. (84mm.). This distal expansion of the tibia, nearly twice that of the shaft, is not really greater than in the smaller species of *Dinornis*, but it takes place so much more rapidly that it is much more conspicuous.

The *metatarsus* which I associate with these tibiæ has a length of 8·5in. (216mm.); the proximal width is 3·5in. (89mm.); the width of the shaft, 1·9in. (48mm.); and the distal width is 4·2in. (107mm.). It closely resembles the same bone in *E. crassus*, and can only be distinguished from it by the greater proximal width, necessary to articulate with the expanded distal end of the tibia. A similar metatarsus is in the collection from Glenmark, and there were one or two in the Hamilton swamp, but I never before saw a tibia like the present one.

I have also temporarily placed here a pair of femora from Enfield, very different from any others, and for which I can find no other place. The length is 11in. (279mm.); proximal width, 4·0in. (101mm.); width of shaft, 2in. (51mm.); distal width, 5·0in. (127mm.). They are specially remarkable for the short head combined with a very stout shaft.

DIMENSIONS OF ENFIELD MOA-BONES.

—	Met.	Tib.	Fem.	Met.	Tib.	Fem.	Met.	Tib.	Fem.	Met.	Tib.	Fem.	Met.	Tib.	Fem.
	D. validus.			D. robustus.			D. potens.			D. torosus.			D. strenuus.		
Length ..	19·0	33 3	16 0	16·7	13·2	15·0	14·7	29·0	13·7	12·6	24·5	12·5	11·3	22·1	..
Width (prox.) ..	4·7	7·2	6·0	4·7	7·5	5·4	4·3	6·6	5·2	3·7	5·7	4·3	3·4	5·5	..
„ of shaft	2·1	2·5	2 3	2·1	2·5	2·4	1·9	2·3	2·3	1·6	1·7	1·9	1·6	1·7	..
„ distal ..	6·2	4·7	6·5	6·2	4·3	6·0	5·4	4·1	6·0	5·2	3·4	5·4	4·5	3.3	..
—	M. rheides.			M. casuarina.			M. didina.			E. crassus.			P. inhabilis.		
Length ..	9·1	19·2	11·3	8·1	17·4	9 7	7·1	15·0	9·1	8·7	19·7	11·3	9·5	20·5	11·9
Width (prox.) ..	3·0	5·4	4·3	3·1	4·8	3·7	2·5	4·2	4·7	3 2	6·0	4·3	3·9	6·4	4·5
„ of shaft	1·6	1·7	1·8	1·6	1·6	1·5	1·4	1·5	1·4	1·9	1·8	1·7	2·1	1·9	1 8
„ distal ..	4·0	2 8	4·7	3·8	2·5	4·0	3·2	2·2	3·7	4·2	3·0	4·9	4·8	3·4	5·3
—	P. valgus.			P. pygmæus?			P. elephantopus.			E. ponderosa.			E. gravis.		
Length ..	8·5	18·0	11·0	6·8	16·7	9·5	9·7	23·0	13·0	8·5	19·5	11·4	7·5	18·0	10 8
Width (prox.) ..	3·5	5·7	4·0	2·8	4·9	3 9	4·3	9·0	5·6	3·8	6·1	4·7	3·0	5 4	3·8
„ of shaft	1·9	1·7	2·0	1·6	1·5	1·6	2·7	2·3	2·3	2·3	2·1	2·1	1·9	1·8	1·9
„ distal ..	4·2	3·3	5·0	3·4	2·6	4·1	6·0	4·1	6·2	4·9	3·2	5·2	4·1	2·7	4 5

Art. IV.—*On* Anomalopteryx antiqua.

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 7th September, 1892.*]

Plate IV.

In my paper on the moas read to this society last year I mentioned some moa-bones which had been found under a lava-stream near Timaru, and named them *Anomalopteryx antiqua.* The description was very imperfect, as I had only seen two fragmentary tibiæ, both of which were much hidden by the matrix in which they were imbedded. I also mentioned that two fragments of a metatarsus, free from matrix, had been found, but that I had not been able to see them. These fragments are shown in the plate accompanying my paper (Pl. IV.), which is taken from a photograph given me by Mr. G. Hogben. They are still missing, but while they were in Mr. Forbes's possession he had moulds made in the museum, and from these I have obtained casts which enable me to add considerably to my former description of this interesting bird. These casts consist of two fragments of a right metatarsus and a small portion of what may be the shaft of a femur.

Proximal Portion of the Metatarsus. Plate IV., figs. 1, 2.

The width is 51mm. (2in.), and the depth, from the bottom of the hypotarsal groove, is 34mm. (1·33in.). The intercondylar ridge is high, projecting in front and rising considerably above the hypotarsal groove: the outer condylar depression is considerably broader and shallower than the inner. The ectocondylar ridge is also high. The inner margin is simply rounded without any longitudinal ridge on the tarsal portion of the bone: the anterior margin is rather strongly sinuated, showing two concavities, one on each side of the intercondylar ridge. The hypotarsal groove is shallow, owing to the slight development of the inner ridge; but the outer ridge is well developed and much broader than the inner one. The interosseous canals, between the metatarsals, open anteriorly together in a deep but small pit, as is usually the case in the *Dinornithidæ*, and the rough surface for the insertion of the tendon of the tibialis anticus is small.

Distal Portion of the Metatarsus. Plate IV., figs. 3–5.

In this fragment the outer trochlea and the outer portion of the middle trochlea are missing. The inner trochlea has a width of 18mm. on its anterior surface, and

a depth of 23mm.; so that the anterior width is less than the depth. The anterior surface is not so oblique as is usual in the other small species of moa, but makes almost a right-angle with the outer surface. It is also directed inwards, well within the inner edge of the middle trochlea (fig. 4). The most remarkable character, however, is its flatness behind (fig. 5), the posterior process, which is so large in all other moas except *Palapteryx dromioides*, being here quite small. The trochlear groove is slight.

The middle trochlea is considerably broader than the inner one, its width being probably about 28mm., but it tapers off rapidly so that its distal width is only about 19mm. Its depth is 26mm. It does not project so far forwards as in most other moas.

The intertrochlear gorge is broad and does not narrow so much at its entrance (figs. 3–4) as in all other moas except *Cela curta*. Its width at the entrance is nearly half that of the inner trochlea.

Supposed Femur. Plate IV., fig. 6.

This is nearly cylindrical, the greatest and least diameters being 28mm. and 26mm. It is remarkable for the thickness of the bony wall, the diameter of the medullary cavity being only about 8mm. or 9mm. This great thickness of the bony wall makes it doubtful if the bone belongs to a bird at all. The only bones of the moa which have so relatively small a central cavity are the toe-bones, and these are always flat on the undersurface. It is also too large for a toe-bone of *A. antiqua*, while its diameter is about what we should expect in the femur of that species. As the bone has disappeared it is impossible now to make a microscopical investigation to test its avian or reptilian character.

Affinities of the Species.

In the high intercondylar ridge our species resembles *Anomalopteryx didiformis*, *Mesopteryx didina*, and *Pachyornis* (?) *geranoides*, and differs from *Cela curta*. In the sinuated anterior margin of the proximal articular surface it most resembles *A. didiformis* and *P. geranoides*, but in these species there is usually only a single concavity on the inner side of the intercondylar ridge. In the absence of a longitudinal ridge on the inner margin it resembles *P. geranoides*, but this ridge is often absent in *A. didiformis* and *C. curta*. In the high ectocondylar margin it most resembles *M. didina* and *P. geranoides*. In the small inner hypotarsal ridge it approaches *Emeus crassus*, but *A. didiformis* sometimes has the inner ridge less than the outer.

The middle trochlea does not project forwards so much as in *C. curta* or *P. geranoides*, and in this point again our species resembles *A. didiformis*. The inner trochlea is not produced so much as in *M. didina* or *P. geranoides*, but resembles that of *C. curta* and *A. didiformis*; it is, however, narrower in proportion to its depth than in either of those species. It agrees with *A. didiformis* in the more transverse direction of its anterior face, which in *C. curta* and in *P. geranoides* is directed almost to the inner edge of the middle trochlea.

The intertrochlear gorge is broader than in *C. curta*, but does not narrow so much at the entrance as in *A. didiformis* and all the other moas.

It thus appears that, while it has distinctive characters of its own, the affinities of *A. antiqua* are more closely with *A. didiformis* than with any other species. It differs, however, from *A. didiformis* in the narrowness and in the shape of the lower surface of the inner trochlea; in the shape of the intertrochlear gorge; in the more rapid tapering of the middle trochlea; in the double sinuation of the anterior margin of the proximal articular surface; and in the small inner hypotarsal ridge. The length of the metatarsus is not known, but the tibia is considerably shorter than that of *A. didiformis*.

It will thus be seen that my inference that the moa bones from Timaru belonged probably to the genus *Anomalopteryx* was a correct one.

DESCRIPTION OF PLATE IV.

Anomalopteryx antiqua.

Fig. 1. Proximal end of metatarsus, front view.
Fig. 2. " " proximal view.
Fig. 3. Distal end of metatarsus, front view.
Fig. 4. " " distal view.
Fig. 5. " " interior view.
Fig. 6. Section of supposed shaft of femur.

Art. V.—*The Moas and the Moa-hunters.*

By Monsieur A. de Quatrefages.

Translated from the French by Laura Buller. Communicated by Sir Walter L. Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 15th February, 1893.*]

When I published my first article in the "Journal des Savants" on New Zealand and its inhabitants,(1) we had received in Europe only the three first volumes of the "Transactions," in which are incorporated the proceedings of the scientific societies of New Zealand. At that time I expressed a regret that this compilation only contained one, and that a very short, notice concerning the large brevipennate birds designated by the common name of "moa."(2) Since then this deficiency has been remedied. The volumes which followed brought us numerous papers dealing with the different questions which the history of these birds has given rise to. I would like to resume here this line of investigation, interesting in so many respects, avoiding the too technical details, for which I can only refer the reader to the works of Drs. Haast, Hochstetter, and others, and especially to those of Professor Richard Owen, which have since become classic.

I.

First of all, let us call to mind the most striking feature of the New Zealand fauna.

Those travellers who were the first to land on this distant soil(3) were surprised to find, in the way of mammals, only a domestic dog, and a rat which the natives hunted as game. Since then there have been discovered two bats of different genera.(4) The researches of geologists have traced back to

(1.) January, 1873. The present article appeared in the same journal (Nos. June and July, 1883).

(2.) "Address on the Moa," by the Hon. W. B. D. Mantell ("Transactions and Proceedings of the New Zealand Institute," vol. i., p. 18). Mr. Mantell was the only one who occupied himself with the general history of the moas. But it is only right to add that Dr. Haast gave in the same volume an entirely technical paper, in which he made known the results of measurements taken from a great number of moa-bones. (*Id.*, p. 80.)

(3.) New Zealand was discovered by Tasman the 13th December, 1642. It was forgotten for more than a century, and rediscovered by Cook the 6th October, 1769.

(4.) *Scotophilus tuberculatus*, Gray, identical with an Australian species, and the *Mystacina tuberculata*, which has never been found anywhere but in New Zealand. (Note communicated by M. Alphonse Edwards.)

palæontological times the same conclusions as those derivable, but with more effect, from a study of living animals. No fossil mammal has yet been discovered anywhere in New Zealand. That renders still more striking the exceptions which I have just pointed out. How are we to explain the existence of these four isolated species, each one representing one of the sub-types of the class, and not having been preceded by any other belonging to the fundamental group? It is a curious fact, and one not to be met with elsewhere. Nowhere else, in fact, do we see a whole class of animals totally wanting in the fossil fauna, and only represented in the existing fauna by a number of insignificant species belonging to distinct orders. On the contrary, there always exist affinities more or less close between the past and the present in the animal kingdom. We know, indeed, that these resemblances are advanced every day as arguments in favour of the doctrine of evolution.

The New Zealand fauna then presents a singular exception to one of the hitherto most generally accepted facts, rendering it thereby extremely difficult to admit the existence of exceptions of this kind. One was naturally impelled to ask whether some accidental phenomenon had not occurred here to disguise the natural features; whether these animals—the dog, the rat, and the two bats—belonged really to the New Zealand fauna, or were merely immigrants brought from a foreign land into a country in which they were previously unknown.

The presence of *Chiroptera* may easily have been attributed to the fact of accidental distribution, resulting from gales such as are still met with in these parts.(5) But the presence of the two terrestrial mammals has remained for a long time unexplained. This curious problem of zoological geography was only solved after Sir George Grey had discovered, translated, and published the historical songs which have furnished information as valuable as it is curious on the first origin of the Maoris. He tells us that in leaving Hawaiki for the land newly discovered by Ngahue the emigrating chiefs took with them the animals and plants the utility of which had been taught them by experience. The dog and rat figure in the list of these treasures of the native colonists,(6) and attest to this

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(5.) The *Zosterops lateralis*, Latham, originally an Australian bird, was brought in this manner to New Zealand, and to the small Campbell Island. It did not exist in the Chatham Islands before 1861. At that time it suddenly appeared after a storm. ("Rapport sur l'Exposition faite au Muséum des Objets d'Histoire Naturelle recueillis par MM. De L'Isle et Filhol," par A. de Quatrefages; "Archives des Missions Scientifiques et Littéraires," vol. v., p. 24.)

(6.) "Polynesian Mythology," 1855 ("The Emigration of Turi," pp. 212 and 214; "The Emigration of Manaia," p. 228). I have analysed these

day the accuracy of the traditions for which we are indebted to a former Governor of New Zealand. They were not indigenous to these Islands, but they were imported by the newcomers.(7)

The mammals which were missing in the natural fauna of this archipelago were somewhat replaced there by birds belonging to a special type, represented in a very small number of species in other parts of the world, and which here exhibited a most exceptional development. I am referring to the birds with rudimentary wings, with filamentary feathers, so to speak, incapable of flight, and bearing a strong resemblance to the ostrich or to the cassowary.(8) Four or five

documents, and all those which relate to this line of argument, in a work entitled, "Les Polynésiens et leurs Migrations," with four accompanying maps. I shall not do more than recall the fact that Hawaiki, which is spoken of here, is one of the Manaia Islands, and most probably Armstrong or Bourouti in our present chart.

(7.) There exist at present in New Zealand mammals brought there by Europeans, the acclimatisation of which was not without its disadvantages. Our rat has almost completely destroyed the rat imported by the immigrants from Hawaiki, the kiore of the Maoris. It is needless to say the mouse accompanied it. Our cat has become wild in these Islands, and it is probably one of these animals which has been mistaken for an indigenous otter, which appears to have once been seen. Our rabbit has multiplied there, as in Australia, to such an extent as to have become a pest to the farmers—so much so that some years ago the Acclimatisation Society of Paris received a request for a certain number of weasels, for which 100 francs a pair was offered. The intention was to liberate them in the hope that they would increase, and exterminate the rabbits. But it was feared the remedy might become worse than the evil. As to the pigs introduced by Cook in 1769, they are now so numerous, and occasion such ravages, that hands are engaged for the express purpose of destroying them. Hochstetter tells us that in twenty months three men, hunting over an extent of 250,000 acres, killed no less than 25,000 wild pigs, and undertook to kill 15,000 more on the same ground ("New Zealand," p. 162). These wild pigs will in the end accomplish the complete extirpation of the last apterous birds, whose nests they destroy. Nevertheless the acclimatisation of foreign animals has progressed with a surprising rapidity in New Zealand. Fourteen species of birds from Europe, Asia, and America have made new homes for themselves in this ocean-girt country. The colonists have not only imported sparrows and larks, but also the pheasant and Californian quail. All the new arrivals have driven out the indigenous species, the representatives of which become more and more rare, several of them being threatened with a speedy extinction. We may add, by the way, that the invasion of New Zealand by foreign plants has been no less general nor less destructive to the indigenous growths. Our cereals and our vegetables everywhere replace the potato (kumara), and are causing the destruction of the fern-root on which the Maoris subsisted. Even our weeds, though involuntarily introduced, have so spread that they choke the plants of the country. "In the Christchurch plain," writes M. Filhol, "however close the search may be, not a Polynesian plant is to be found. One might as well go through our French province of Beauce" ("Rapport sur l'Exposition faite au Muséum des Objets d'Histoire Naturelle recueillis par MM. De L'Isle et Filhol," *loc. cit.*).

(8.) Out of New Zealand the ornithological type of which we

species of this group still exist in New Zealand. The natives call them "kiwi"; and they have been placed by naturalists in the genus *Apteryx*. The size of the body varies between that of a fowl and a turkey. But the number of extinct species is very considerable; and amongst them were found some of truly gigantic proportions. It is these extinct species which are called by the common name of "moa," which is borrowed from the Maori language.(9) The first researches in this curious chapter of ornithology date from 1830. The celebrated English anatomist, Richard Owen, had received from a Mr. Rule the middle portion of a femur; and on examining this single fragment he drew conclusions which everything has since confirmed.(10) Materials more abundant and more complete soon enabled him to recognise five distinct species, which he united in the genus *Dinornis*. Later on this number was progressively increased to thirteen, and there were found in the representatives of an extinct fauna different characteristics more and more pronounced: so much so that Dr. Julius Haast, the eminent New Zealand geologist, thought he could distinguish four genera, which he divided into two groups or families.(11) It is easy to see that these palæontological dis-

are speaking here is only represented by four species, each one of different habitat, and isolated from each other by vast distances. They are: the ostrich (*Struthio camelus*, Linnæus), which inhabits nearly the whole of Africa, Arabia, and the hot parts of Asia on this side of the Ganges; the rhea, or American ostrich (*Rhea americana*, Latham), which inhabits South America from Brazil to Patagonia; the crested cassowary (*Casuarinus emeu*, Latham; *Struthio casuarius*, Linnæus), which is only found in the Indian Archipelago, and principally in the forests of Ceram; lastly, the emu (*Casuarius novæ-hollandiæ*, Latham), which seems to have spread all over Australia, but is being rapidly destroyed by the European colonists, who will shortly annihilate it.

(9.) These species are *A. australis*, *A. mantelli*, *A. oweni*, *A. haasti*. A fifth species of large proportions perhaps exists in the remote districts of the Middle Island. It was actually described by Verreau, a travelling French naturalist. But he had only seen one skin, the feathers of which a Maori chief used for his mantle. (Note communicated by M. Alphonse Edwards.)

(10.) The kiwis lived at the same time as some species of moa. Their bones have been found intermixed in caves, and also in the kitchen-middens of which I will speak later on. The moas are not the only species that have disappeared from New Zealand. Owen has shown that it was the same with two species of rail of which he has made the genus *Aptornis*. Haast has described the remains of a large bird of prey which he called *Harpagornis moorei*. This is perhaps the "weka" mentioned in some of the Maori traditions. ("Notes on *Harpagornis moorei*," by Julius Haast: Transactions, vol. iv., p. 192, pls. x. and xi.)

(11.) Professor Richard Owen made his first communication on this subject to the Zoological Society of London the 13th November, 1839 (Laurillard, article on "Dinornis," in the "Dictionnaire Universel d'Histoire Naturelle" by D'Orbigny). Professor Owen was able to pro-

coveries confirm the observations that I put forward just now, and make New Zealand conform to the general rule. This distant country has never produced mammals. The type of brevipennate birds has developed itself into an abundance and variety of subordinate groups, met with nowhere else. There is complete accord between its fossil fauna and its living fauna; and these faunæ by the very characteristics which are common to them further attest the universality of the law which everywhere links together the past and the present in the animal world.(12)

The number of moa-bones collected by scientists or by amateurs living in New Zealand is very considerable; and it is only just to recognise the generosity with which these scientific treasures have been shared with other scientists all over the world. All the large museums of Europe and America possess more or less complete skeletons of these strange birds. Mr. Walter Mantell, who was one of the first to occupy himself with this question, sent Richard Owen more than a thousand bones.(13) When the learned geologist of

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secute his studies mainly through the materials sent by Mr. W. Mantell. The results appeared in the "Transactions of the Zoological Society" of 1884 and following years.

(12.) Here is Dr. Haast's classification, which only comprises eleven species:—I. Family of *Dinornithidæ:* Genus *Dinornis*, comprising *D. maximus*, *D. robustus*, *D. ingens*, *D. struthioides*, *D. gracilis;* genus *Meionornis*, comprising *M. casuarinus*, *M. didiformis*. II. Family of *Palapterygidæ:* Genus *Palapteryx*, comprising *P. elephantopus*, *P. crassus;* genus *Euryapteryx*, comprising *E. gravis*, *E. rheides*. ("Proceedings of the Philosophical Institute of Canterbury," March, 1874; "Address," by J. Haast, President; Transactions of the New Zealand Institute, vol. vi., p. 426.) Dr. Haast, basing himself upon the scale of dimensions, seems inclined to believe that he himself reunited, under the name of *Meionornis casuarinus*, two species which must hereafter be distinguished. He says the same with regard to *Palapteryx elephantopus* (p. 429). Professor Hutton, Director of the Otago Museum, criticized Dr. Haast's classification, contradicting some of the facts quoted by his colleague. He thinks, like Owen, that all the moas formed one natural family, that of *Dinornithidæ*. (Transactions, vol. ix., p. 363.) Owen and M. A. Edwards admit only two kinds, *Dinornis* and *Palapteryx*, the former tridactyle, the latter with a fourth finger, short and directed backwards.

(13.) The preceding observations do not only affect the history of the New Zealand fauna: they are closely related to the history of man himself. In themselves they are sufficient to refute a theory recently put forward by M. P. A. Lesson—in a book filled, however, with important documents and facts, three volumes out of four of which have appeared: "Les Polynésiens, leur Origine, leurs Migrations, et leur Langage:" Paris, 1882. The author admits that the whole of Polynesia—Tahiti, the Sandwich Islands, Samoa group, Tonga group, &c.—has been peopled through migrations; but, instead of considering the Malay Archipelago as a racial starting-point, he makes New Zealand the birthplace of the Polynesian. Thus he returns to the old idea of autochthonism, which is little to be relied on, as Mr. H. Hall's magnificent work has already

the "Novara," Professor Hochstetter, proposed to explore in the marshes and bone-caves, he met everywhere with the most ready concurrence. It was the same with our compatriot, M. Filhol.(14) It is to the good-will and the liberality of our New Zealand fellow-workers—Dr. Julius Haast and Captain Hutton in particular—that we owe the magnificent skeletons which are now to be seen in our museum. No one will blame me for having given prominence to these facts, or for having here acknowledged publicly the services of the men who appreciate and act so fully up to the principles of scientific brotherhood.

II.

This abundance of material enables one to form a very complete idea of what the moas were. It has been possible to reconstruct entire skeletons of several species, and thus to judge of their proportions. On the whole, and in spite of the minor differences which distinguish them, all these birds remind us, as I have already said, of the ostrich and cassowary. The head is small; and nothing belonging to it indicates the existence of a solid casque similar to that which distinguishes another struthious bird, and which has gained for it the name of "the helmet-headed cassowary." The neck is very long, slender at first, thickening progressively towards the trunk, as in the cassowary. The skeleton of the body is robust. The sternum alone is relatively very small and flat. The reduction of this bone, so developed in birds which fly, is explained by the smallness of the wings, which are really rudimentary. On the other hand, all the parts of the skeleton belonging to the posterior members assume exceptional dimensions. The sacrum is massive; the bones of the thigh, leg, and toes have enormous epiphygeal heads, and the bone itself is relatively much thicker than in the living representatives of the type. These characteristics are especially marked in the *Palapteryx elephantopus*, which was rather smaller than our ostrich; notwithstanding which, the bones of its foot had a circumference nearly double that of the same member in the ostrich and cassowary.(15) The stature varied very per-

shown; and at the same time he places the cradle of the insular Polynesian in the land to which an hypothesis of this kind is least applicable. I have already briefly examined M. Lesson's theory, and shown how, independently of the data furnished by the study of the faunæ, the historical records, for which we are indebted partly to the author himself, but especially to Sir George Grey, Thomson, Shortland, &c., prevent its being accepted ("Hommes Fossiles et Hommes Sauvages," p. 483). I will return to this subject when M. Lesson's book is finished.

(14.) Hochstetter, *loc. cit.*, p. 182.

(15.) MM. Filhol and De L'Isle were attached in 1874 as naturalists to the expedition sent to observe the transit of Venus in the Islands of

ceptibly in the different species of moa. The smallest—*Meionornis didiformis*—was only three or four feet high.(16) It was therefore very inferior to the ostrich, the height of which varies from six to seven feet. But the *Palapteryx ingens* was of precisely similar size to the latter. *Dinornis robustus* was from eight to nine feet high, and *Dinornis maximus* nine or ten feet in height. It therefore exceeded our largest ostriches by about three feet.(17) According to Thompson, quoted by M. Alphonse Edwards in an unpublished paper which he was good enough to communicate to me, there existed individuals reaching to thirteen or fourteen feet in height. The accompanying plate* will give an idea of what these enormous brevipennate birds must have been.(18)

In comparing a large number of bones of adult individuals of the same species, Dr. Haast recognised that they always formed two series of slightly different sizes. He attributed this inequality to the sex, and, guided by what exists in the *Apteryx*, he considered the larger bones as having belonged to

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St. Paul and Campbell, under command of Admirals Mouchey and Bouquet de Lagrye. Both of them brought back valuable collections. But M. De L'Isle, prevented by illness, could not realise all that his experience and zeal had given promise of. M. Filhol fulfilled his mission in a remarkable manner. After having thoroughly explored Campbell Island, he went twice to New Zealand, running through the principal provinces. He finally visited the Viti Islands, New Caledonia, the Sandwich Islands, returning to France by way of San Francisco. From every part he brought back remarkable collections, and observations full of interest. Captain Hutton, Director of the Otago Museum, gave M. Filhol, for our Museum, numerous moa-bones and two complete skeletons—one of *Palapteryx elephantopus*, the other of *P. crassus*. ("Rapport sur l'Exposition faite au Muséum des Objets d'Histoire Naturelle recueillis par MM. De L'Isle et Filhol," *loc. cit.*) Dr. Haast sent us, with a large number of isolated bones, four almost perfect skeletons, which have been mounted, of *Dinornis crassus*, *giganteus*, *elephantopus*, and *didiformis*. The Museum possesses, besides, a model in plaster of the magnificent *Dinornis ingens* procured by Hochstetter, which he reconstructed and figured in his book, pp. 187 and 188. The objects brought by MM. De L'Isle and Filhol were publicly exhibited, and filled the large hothouse of the Museum. A report was made on these collections, which I have often quoted.

(16.) Hochstetter, *loc. cit.*, p. 138.

(17.) I borrow all these figures from Hochstetter's table of measurements (*loc. cit.*, p. 198). The learned traveller seems to have judged of the size, not by measuring the distance from the beak to the extremity of the feet, but by supposing the bird at rest in its natural position, the neck inclined forward and presenting a double curve, as he represented the *Palapteryx ingens* the skeleton of which is at Vienna (*loc. cit.*, p. 188).

(18.) This figure, taken from a photograph, was published first by Dr. Haast, "Geology of the Provinces of Canterbury and Westland." M. De Quatrefages reproduced it in a work recently published, "Hommes Fossiles et Hommes Sauvages," 1 vol. in 8vo., 209 figures in the text, and a map (J.-B. Baillière). The editors were kind enough to put at our disposal the woodcuts, for which we here express our thanks.*

* Not republished.—Ed.

the females.(19) The discovery has not been limited to osseous remains of moas of different sexes and ages. Myriads of fragments of egg-shells have been found, and some entire ones; but unfortunately most of the latter have got broken. However, a sufficient number of eggs have been restored.(20) These eggs, of a pale-yellow colour, had the surface picked out, as it were, with minute pointed furrows.(21) Their size was much superior to that of ostrich-eggs, without equalling, however, in this respect, the eggs of the *Æpyornis*.(22) In one of them were found the bones of a young chick, and Dr. Hector was able to compare them with those of an emu chick of the same age.(23) It is interesting to notice that in the birds belonging to this period the principal distinguishing characters are very manifest, and that the lower framework, the leg-bones, &c., are much more robust in the moa than in its near ally inhabiting Australia.

(19.) "Address," Transactions, vol. vi., p. 428.

(20.) Mr. Mantell himself reconstructed a dozen of these eggs, which have for the most part been given to the British Museum and the Royal College of Surgeons. Amongst these, which highly illustrate the skill and patience of the manipulator, there are some which number no less than two or three hundred fragments. ("On Moa-beds," Transactions, vol. v., p. 94.)

(21.) "On the Microscopical Structure of the Eggshell of the Moa," by Captain F. W. Hutton (Transactions, vol. iv., p. 166, pl. ix., figs. 1, 2, 3, 4, and 5). The eggshell, about $\frac{7}{100}$in. in thickness, is composed of two layers. The outer part is marked by parallel furrows, the inner part up to the surface being formed of a kind of small perpendicular prism. Other observers speak of these eggs as being perfectly smooth. It is quite possible that the little furrows in question are due to the action of sand blown about by the wind. We know, really, that this action is exercised even on rocks, much more capable of resistance than eggshells, and this fact has been distinctly proved in New Zealand.

(22.) The *Æpyornis maximus* inhabited Madagascar. It was destroyed by man, but it is not known at what epoch. The eggs and some bones have been described for the first time by Isidore Geoffroy-Saint-Hilaire ("Comptes Rendus de l'Académie des Sciences," 1851, vol. xxxii., p. 101; and "Annales des Sciences Naturelles," 3rd series, vol. xiv., pp. 206 and 213). M. Alphonse Edwards, having received new materials, has prepared a very complete work on this species, "Recherches sur la Faune Ornithologique Éteinte des Îles Mascareignes et de Madagascar," p. 85: 1873. The result of the studies of this naturalist is that the *Æpyornis* was closely related to the moa, while presenting certain characteristics sufficient to constitute the type of a family comprising probably three species. In particular the bones of the metatarsus were still thicker and more massive than with *P. elephantopus*. It was about 6ft. high. The eggs, several specimens of which he possesses, have a capacity of about two gallons—that is, the volume of six ostrich-eggs or a hundred and forty-eight fowl-

(23.) "On Recent Moa-remains in New Zealand," by James Hector, M.D., F.R.S. (Transactions, vol. iv., pl. vi., figs. 3 and 4). The same plate gives the drawing of moa- and emu-eggs reduced to a third (figs. 1 and 2). Letter from Mr. T. M. Cockburn-Hood to Dr. Hector (Transactions, vol. vi., p. 387).

From time to time, and in different localities, there have been found stray moa-feathers, belonging to different parts of the body, and even portions of skeletons to which still adhered muscles, tendons, and fragments of skin, as well as feathers, in a remarkable state of preservation.(24) Later on I will refer to the conclusions which may be deduced from the above-stated facts. I only mention the subject now for the purpose of completing the description of these birds.

Captain Hutton has examined feathers found in two localities associated with moa-bones. These feathers belonged to the same species. They were as fresh, and the colours were as bright, as if they had only just been plucked out. But, with the exception of one which he figures, they were all broken.(25) Their total length is about 6⅛in. The tube is only about ⅛in., and has two very slender shafts, the barbs of which, although provided with barbules, remain disconnected. These barbs, at first very short, attain a length of about an inch, and the plume terminates in a rounded tip. For two-thirds of their length from the base the colour is a reddish-brown, which passes gradually into black, whereas the rounded extremity is of the purest white. Captain Hutton observes that the general effect of these characters appears to establish a close connection with the American and Australian brevipennates rather than with the African ostrich.(26) Besides, one can understand that all the moas had not the same kind of plumage. Mr. Taylor White's discoveries have confirmed on this point all that might have been expected. In the cave of Mount Nicholas he found feathers of a pale brownish-yellow, darker along the edges. Some were of a blackish-brown. Feathers coming from another cave, near Queenstown, were of a reddish-brown, and marked by a dark-brown streak towards the extremity of the shaft.(27) We know, therefore, at least partially, what the plumage was in, at any rate, three species of moa.(28) The feathers I have just described were, no doubt, from the middle or hinder region of the body. The rare specimen described and figured by Dr. Hector shows the modifications which the anterior dorsal

(24.) "Address on the Moa" (extracts), by the Hon. W. B. Mantell (Transactions, vol. i., p. 19). "On some Moa-feathers," by Captain F. W. Hutton (Transactions, vol. iv., p. 172). "On Recent Moa-remains in New Zealand," by James Hector, M.D., F.R.S. (Transactions, vol. iv., p. 110). Similar facts are frequently mentioned in other papers to which I shall have occasion to return further on.

(25.) *Loc. cit.*, pl. ix.

(26.) *Loc. cit.*, p. 173.

(27.) *Loc. cit.*, p. 114, pl. v., with five figures.

(28.) "Notes on Moa-caves in the Wakatipu District," by Taylor White, Esq. (Transactions, vol. viii., p. 97).

region and the neck presented in this respect.[29] This specimen comprises seven vertebræ—the first dorsal and the six last cervical—united by their ligaments, and having preserved on one side their muscles and other integuments. The author concludes that the neck of this moa was 18in. in circumference at its base. On the portion of the specimen corresponding to the dorsal vertebræ one sees the skin covered with large conical elevations or papillæ, which almost touch each other, and give to the whole the aspect of a grater. A certain number of these papillæ have feathers of a reddish-chestnut colour, with two shafts, and provided with barbs, similar to those mentioned above, the longest of which are more than 2in. in length. The papillæ diminish in size, and the feathers in length, on reaching the part overlying the cervical vertebræ. The feathers are then rapidly reduced to mere hairs, and they disappear entirely over about half the surface of the specimen. There the papillæ are much less pronounced, and are quite distinct from each other.

Keeping in view these varied data, and the characters which distinguish the brevipennate birds of other regions, we can form a very precise idea of what the large species of moa were. They presented the general form of the cassowary, but on a much larger scale.[30] As with the latter, the greater part of the neck was bare, but the characteristic crest was absent, and consequently they approached more closely to the emu. Very probably the legs were bare and the body was covered with silky feathers, where tints of a dark reddish-brown predominated, varied with black and white, at least in some of the species.

Writings to which I shall have to refer later on enable us to complete the picture, and go to illustrate the manner of life of these strange birds.[31] The moas were sluggish and stupid creatures, as attested by a proverb still in use.[32] They were essentially sedentary, and walked in couples accompanied by their young. No doubt they sometimes disputed possession of the same feeding-ground, for the Maoris still say, speaking of a fight between two pairs of combatants,

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(29.) Note added to the preceding by Captain F. W. Hutton (*id.*, p. 101).

(30.) The cassowary is smaller than the ostrich.

(31.) Letter from Mr. John White to Mr. Travers (Transactions, vol. viii., p. 81). Mr. Travers tells us that his correspondent was engaged for more than thirty-five years in collecting every possible piece of information about the past history of the moas; that he had been initiated by their priests into all the mysteries of the native craft, so that he knew the history of their race better even than the natives themselves.

(32.) Extracts from a letter from F. L. Maning, Esq., relative to the extinction of the moas (Transactions, vol. viii., p. 102). The author translates the Maori proverb by the words "As inert (*ngoikae*) as a moa."

"Two against two, like the moas." Their nest was formed of various dry herbs, and of the *débris* of ferns, heaped together. They fed on different kinds of plants growing on the outskirts of the woods and along the borders of the swamps—on the young sprouts of various shrubs, &c.; but their principal food appears to have been the root of a species of fern, which they tore up either with the beak or the feet. To aid in the digestion of this food, the moas, like many other birds, swallowed little pebbles, which, rounded and polished by the friction in their stomach, assumed a peculiar form, and are called to this day "moa-stones" by the natives, who are familiar with them.(33) But this polish rendered the stones useless for the purpose intended by the birds; whereupon they were disgorged, after the manner of the ostrich and the emu.(34) These stones were not always of the same kind, and varied with the locality.(35)

III.

The details I have just given lead us to suppose not only that man and the moa were cotemporary, but also that the disappearance of the latter dates from a recent epoch. Such, in fact, is the conclusion arrived at after a thorough investigation, carried on in New Zealand for nearly forty years, by a large number of inquirers and distinguished scientists. Nevertheless, until a few years ago it was possible to entertain doubts. One of the most distinguished New Zealand geologists, Dr. Julius Haast, expressed himself decidedly of a contrary opinion. Although accepting as proved the co-existence of men and moas at a very remote epoch, answering to our prehistoric times, he denied that the actual Maoris had ever known these large birds.(36) On the other hand, Mr. W. Mantell, whose numerous researches render him on this point a safe authority, has clearly, and at different times, expressed an opposite view, arguing that these large brevipennates were hunted and exterminated, not long ago, by the present race of Maoris.(37)

(33.) Hochstetter, p. 186.

(34.) "Note on Discovery of Moas and Moa-hunters' Remains at Pataua River, near Whangarei," by J. Thorne, jun. (Transactions, vol. iv., p. 66, 1872). A certain number of these *moa-stones* have been collected, and figure in the Auckland Museum and very probably in many other New Zealand collections.

(35.) Haast, *loc. cit.*, p. 73.

(36.) "Moas and Moa-hunters," address to the Philosophical Institute of Canterbury, 1871, by Julius Haast (Transactions, vol. iv., p. 66, 1872). Dr. Haast maintained his first impressions in other memoirs and in the work which he published under the title of "Geology of the Provinces of Canterbury and Westland, New Zealand," 1879.

(37.) "On the Fossil Remains of Birds collected in Various Parts

Finally, Mr. Stack, considered by his colleagues a very competent judge, has adopted an intermediate opinion. He regards the belief of the recent extermination of the moa as inadmissible, without wishing, however, to throw it back into a too-remote past.(38)

To show how the question has been elucidated, and in order to justify the opinion at which I have arrived, I must go into further particulars.

Moa-bones have been met with in deposits of very different kinds. Sometimes they are to be found lying on the surface, or are scarcely even covered with a few inches of sand;(39) but generally one finds them buried at variable depths in the sand on the sea-coast, in alluvial deposits from rivers, in swamps, and also in caves. The quantity of these remains, and their accumulation on limited spaces, is sometimes very remarkable.

In digging watercourses for draining a swamp at Glenmark, the workmen extracted the remains of 144 adult birds and of twenty-seven young ones.(40) I could quote many other examples, but I limit myself to recapitulating the details given by Mr. Booth on the discovery made by him at Hamilton in a little lagoon almost dried up.(41) Apprised of the discovery of some bones, he had a pit opened measuring 4ft. square, and took out of it fifty-six femora, with a proportionate number of other bones. Regular excavations were then organized. It was proved that the place explored formed a sort of irregular crescent, measuring 40ft. from one end to the

of New Zealand by Mr. Walter Mantell, of Wellington," by Gideon Algernon Mantell, Esq., LL.D., F.R.S. ("Quarterly Journal of the Geological Society of London," vol. iv., p. 225, 1848). "Address on the Moas" (extracts), by W. B. Mantell (Transactions, vol. i., p. 18, 1869; with two plates). Nevertheless, in this last paper Mr. Mantell seems disposed to place farther back the time of the moa's extinction, relying on the obscure traditions which he collected on this subject. Mr. White's letter, which I have already quoted, and to which I shall soon return, responds plainly to this objection.

(38.) "Some Observations on the Annual Address of the President," by the Rev. J. W. Stack (Transactions, vol. iv., p. 107).

(39.) Dr. Hector, *loc. cit.*, p. 115; Haast, *loc. cit.*, p. 103; Stack, *loc. cit.*, p. 109; the Rev. R. Taylor (Transactions, vol. v., p. 97). These bones, which were seen in great quantities scattered over the ground, have rapidly disappeared. Mr. Stack explains their permanence during centuries by saying that the Maoris carefully preserved the woods, while the European colonists did their best to destroy them. The latter, in destroying this shelter, facilitated the action of the atmospheric agents, and brought about the disappearance of these bones, which up till then had remained intact. I think it is useless to point out how ill-founded this interpretation of facts is, and how opposed to daily experience.

(40.) Haast, *loc. cit.*, p. 89.

(41.) "Description of the Moa-swamp at Hamilton," by B. S. Booth (Transactions, vol. vii., p. 123, pl. v.).

other, 18ft. in the centre, and from 2ft. to 4ft. in depth. In this very limited space about 3½ tons weight of bones were collected, the number of moas piled up in this estuary being estimated at more than four hundred.

These bones were very unequally preserved. A large number fell to pieces at the least touch. They had evidently not been deposited at the same time. But, owing to the conditions under which the entombed remains were found at Hamilton, this instance scarcely furnished exact data respecting the relative ages of these deposits. It is different with regard to the caves scientifically explored by Hochstetter. Here, quite distinct beds, separated by layers of stalagmites, contained different species. At the top was found *Meionornis didiformis*, and below *Palapteryx elephantopus*. The bones of the former seemed to be still fresh, whilst those of the latter were half fossilised. This diversity of aspect corresponds with the difference in chemical composition, due to a more or less complete change in their tissue. The quantity of organic matter found in moa-bones which have been analysed is very variable. Sometimes it is only 10 per cent., while at other times it reaches 30 per cent.; this proportion being almost exactly the same as that found in fresh ostrich-bones.(42)

Hochstetter, arguing from his personal observations and from some already-known facts, came very near the opinions of the Messrs. Mantell (father and son). He thought that the extinction of the moa should not be carried back thousands of years.(43) He considered that their existence alone could explain the development which the population of New Zealand had undergone,(44) and attributed the origin of anthropophagy to the want of animal food, resulting from the extermination of these birds.(45) He consequently identified the present race of Maoris with the moa-hunters. In support of his very opposite view, Dr. Haast takes geology for a basis. Moa-bones, he says, are principally found in the deposit formed during the glacial period, or immediately after it.(46) Having himself collected a certain number of these bones *in situ*, it seemed to him that these large birds represented in New Zealand the gigantic quadrupeds which inhabited the Northern Hemisphere during the Post-pliocene period. Therefore he did not hesitate to carry back the existence of the moa to an epoch quite as far removed from present times as that of the mammoth, rhinoceros, lion, and cave-bear, the bones

(42.) Hochstetter, p. 190.
(43.) P. 190.
(44.) *Loc. cit.*, p. 194.
(45.) *Id.*, p. 196.
(46.) Haast, *loc. cit.*, p. 68.

of which are found in the Quaternary deposits of Europe; and he affirmed that if the moa had outlived these times, geologically different from ours, it had not been long in becoming extinct.(47)

One can see that Dr. Haast seemed to admit not only the analogy of the glacial phenomena operating alike in New Zealand and in Europe, but also their contemporaneity. But this is a question of pure geology, which is beyond my capacity. Nevertheless, if we accept these two propositions as true, and if we argue by analogy, we might make serious objections as to the conclusions which the New Zealand scientist draws with regard to the remote extinction of the moa.

It is quite true that these large mammals spoken of by Dr. Haast no longer exist, and are only known to us by their remains. But beside them lived other species, which have survived and are still existing. The monks of St. Gall still ate the urus in the fifteenth century; the reindeer, in the time of Pallas, descended in the depth of winter as far as the borders of the Caspian Sea; the auroch and the elk are still to be found in Poland; the chamois, the wild goat, and the dormouse still survive around us. Why, therefore, should all the different species of moa have been condemned to perish with the geological period which saw them appear?

Dr. Haast would no doubt reply that the European mammals above mentioned, and others which it is unnecessary to enumerate, have generally emigrated either in latitude or in altitude. But, without even making the action of man interfere, this change of habit might be caused by a radical change of climate. The latter, *insular* in the glacial times, had become *continental*. In New Zealand it was not so. Whatever may have been the upheaval or depression of the land,(48) it has remained isolated in the midst of the ocean, and the climate has not varied, at any rate in the lower levels, except within very prescribed limits. Dr. Haast himself, in setting forth other facts besides those which I have indicated, urges similar views, and shows very clearly how in this large island the extension of glaciers by no means involves the

(47.) *Loc. cit.*, p. 75.

(48.) The Transactions contain several memoirs giving an account of the glacial phenomena which occurred in New Zealand. I will merely mention those of Messrs. Travers and Dobson, who, in expressing their own views, have recapitulated those of their colleagues. "Notes on Dr. Haast's supposed Pleistocene Glaciation of New Zealand," by W. T. L. Travers (Transactions, vol. vii., p. 409). "On the Date of the Glacial Period," by A. Dudley Dobson (*id.*, p. 440). But the work which ought especially to be consulted on this question is that of Dr. Haast on the geology of the Provinces of Canterbury and Westland.

existence of a climate much more rigorous than that of to-day.(49) The general conditions of existence remaining the same, what reason can the New Zealand palæontologist have for considering the extinction of all the moas a necessity?

In all his writings published up to this date which have come to my knowledge, Dr. Haast maintains the general opinions we indicated above.(50) It appears that they have for him the value of so many axioms involving a certainty, and thus the positive or negative facts have value in his eyes only so far as they accord with his theory. If one mentions to him skeletons more or less complete, found on the surface beside a little heap of moa-stones, which seem to indicate that the bird died there and was never buried, he declares himself unable to comprehend that these bones have resisted the action of atmospheric agents during hundreds if not thousands of years.(51) If one speaks to him of the traditions preserved by the natives relating to the existence of the moas—their external characters, their manner of life, and the means employed in killing them—he replies that the most civilised Europeans have no traditions connected with the mammoth and rhinoceros; and that an inferior race, which only reached a state similar to that of our Neolithic people, cannot have retained any recollection of a period of such remote antiquity.(52) He adds that eminent men have looked in vain for traditions of the class he refers to.(53) He, like Mr. Colenso, dwells on the fables which are in New Zealand, as in every other country, mixed up with the true history in the memory of the people.(54) He connects what is said about the moas with vague memories relating to the cassowary which had been brought by the Maoris from their first home,(55) and also to information furnished by

(49.) *Loc. cit.*, p. 72.

(50.) Independently of the address quoted above, Haast published in the Transactions of the New Zealand Institute the following memoirs on the same subject:—Vol. iv., 1872. "Additional Notes," p. 90; "Third Paper on Moas and Moa-hunters," p. 94, pl. vii. Vol. vii., 1875: "Researches and Excavations carried on in and near the Moa-bone Point Cave, Sumner Road, in the Year 1872," p. 54; "Notes on an Ancient Native Burial-place near the Moa-bone Point Cave, Sumner," p. 86, pls. iii. and iv.; "Notes on the Moa-hunters' Encampment at Shag Point, Otago," p. 91; "Results of Excavations and Researches in and near the Moa-bone Point Cave, Sumner Road" (postscript), p. 528. Haast maintained, moreover, his theory, and the conclusions which he draws from it, in his book entitled "Geology," &c., 1 vol. in 8vo, 1879.

(51.) Address, p. 71.

(52.) Address, p. 75.

(53.) P. 76, and following.

(54.) P. 75.

(55.) P. 77.

some accidental immigrants.[56] The examination of the cooking-ovens, which are similar to those of the present natives, and the remains of feasts containing moa-bones, show him the contemporaneity of certain human beings and these birds;[57] but the first are in his eyes a population absolutely savage, only knowing how to cut and not to polish the stone. If there have been found polished adzes mixed up in the ancient kitchen-middens,[58] it is, he affirms, because they have been lost or intentionally hidden in modern times, long after the moa-hunters had disappeared.[59] These, he says repeatedly, have never had anything in common with the Maoris who occupied New Zealand at the time of the arrival of Europeans.

I think I have sufficiently indicated the mode of reasoning and the nature of the arguments employed by Haast. I will not attempt to follow him here in the discussion of many subjects which he touches upon, but which relate only in an indirect manner to the principal question. Nevertheless I think I ought to quote verbatim the conclusions which terminate his third memoir:[60]—

"1st. The different species of the *Dinornis*, or moa, began to appear and flourish in the Post-pliocene period of New Zealand.

"2nd. They have been extinct for such a long time that no reliable traditions as to their existence have been handed down to us.

"3rd. A race of autochthones, probably of Polynesian origin,[61] was cotemporaneous with the moa, by whom the huge wingless birds were hunted and exterminated.

"4th. A species of wild dog was cotemporaneous with them, which was also killed and eaten by the moa-hunters.

"5th. They did not possess a domesticated dog.

"6th. This branch of the Polynesian race possessed a very low standard of civilisation, using only rudely-chipped stone implements, whilst the Maoris, their direct descendants,[62]

(56.) P. 106.

(57.) P. 82.

(58.) I quote the expression by which Haast evidently translates the word *kjækkenmæddings*, which has become classical since the works of Danish scientists. We know that it means "kitchen remains."

(59.) Pp. 85, 104.

(60.) "Third Paper" (Trans., vol. iv., p. 106).

(61.) "A race of Autochthones, probably of Polynesian origin." It is difficult to understand the association of ideas which Dr. Haast wishes to express here.

(62.) "Their direct descendants." Here, again, it is no easy matter to understand Dr. Haast's idea. Everywhere he carefully distinguishes the actual Maoris from the moa-hunters. Here he seems to regard the first as descendants of the latter.

had, when the first Europeans arrived in New Zealand, already reached a high state of civilisation in manufacturing fine polished-stone implements and weapons.

"7th. The moa-hunters, who cooked their food in the same manner as the Maoris of the present day do, were not cannibals.

"8th. The moa-hunters had means to reach the Northern Island, whence they procured obsidian.(63)

"9th. They also travelled far into the interior of this Island to obtain flint for the manufacture of their primitive stone implements.

"10th. They did not possess implements of nephrite (greenstone).(64)

"11th. The polishing process of stone implements is of considerable age in New Zealand, as more-finished tools have been found in such positions that their great antiquity cannot be doubted, and which is an additional proof of the long extinction of the moa."

It would appear here that Dr. Haast claims to be absolutely certain on every point, and it is with an air of perfect confidence that he affirms or denies the several facts. But we shall see that he ought to have reconsidered his propositions, and acknowledged that some of them, at any rate, were wrongly founded. Nevertheless, the general convictions of the learned geologist have not been shaken, and we shall have now to ascertain whether this obstinacy is justifiable.

IV.

While making a distinct difference between the moa-hunters and the Maoris, Dr. Haast affirmed that the former limited themselves to rudely shaping their stone implements, whilst the latter knew how to give them a polish of which we can judge by numerous specimens.(65) He added that the moa-hunters did not possess greenstone implements—that is to say, implements formed out of a stone often confounded with jade, and which the natives, when discovered by the early navigators, were found to value very highly.(66)

These two propositions had a very great importance from

(63.) Dr. Haast's researches were made principally in the Province of Canterbury, situated in the South Island.

(64.) It was with this stone, often called "jade," that the Maoris made their tomahawks, their axes, and different ornaments. They were of great value in their eyes, and play a prominent part in their legends. I have given on this point a few details, borrowed from Sir George Grey, in the book entitled "Les Polynésiens et leurs Migrations."

(65.) Sixth proposition.

(66.) Second proposition.

the point of view of the theory maintained by the New Zealand scientist. They tended to establish another point of connection with what had happened in Europe. We know that the *rough-stone adze* and the *polished adze* are among the number of characteristic features which in Europe distinguish two epochs. We know also that the populations of these two epochs belonged to different races, and that the more civilised one had attacked and vanquished that race which had preceded it. To find again in New Zealand our two ages, Palæolithic and Neolithic, characterized thus by implements indicating a difference of social status, was to bring a serious argument in favour of the ethnological distinction between moa-hunters and Maoris. But in excavating the Sumner Cave and the neighbouring cliffs Haast himself discovered, at different times, fragments of adzes and other highly-polished implements, as well as pieces in the rough, resembling in every respect those that we know to be the work of the Maoris. Some of these objects were in greenstone. They were all found under conditions attesting their cotemporaneity with the men who had hunted and eaten the large brevipennate birds. I shall confine myself to a reference to one adze which was placed immediately below some stones forming the oven which had served for cooking moas.(67) In the face of these material proofs collected by himself, Dr. Haast does not hesitate to recognise with perfect candour that the moa-hunters had attained a degree of civilisation equal to that which the Maoris presented when the Europeans visited New Zealand for the first time.(68)

We are, I think, authorised to believe that this equality of social development, manifesting itself by similar industrial characteristics, ought to have inspired in the learned New-Zealander some doubt as to the correctness of his theory. All the same, Dr. Haast has not renounced any of his preconceived ideas. He persists in denying the ethnical identity of the moa-hunters and the Maoris, and in throwing back into a past which he considers as geological the period of the disappearance of the moa.(69) As far as I can see, Mr. Colenso seems to be the only one who has accepted this doctrine in

(67.) "Researches in Sumner Moa-cave" (Transactions, vol. vii., p. 77).

(68.) *Id.*, p. 80. Before Dr. Haast had retracted his views on this particular point, numerous discoveries had been made in different places of implements and weapons in polished stone, mingled with moa-remains. Higher up I mentioned how Dr. Haast had tried to explain and interpret these facts, so I will not repeat it. The clear and honest declaration of the eminent geologist absolves me from entering into any details here.

(69.) Haast, "Geology," &c. Note especially the thirteen propositions set forth, p. 430, and chap. xvi. (*c*), p. 437.

its full appreciation.(70) I have already mentioned how Mr. Stack refuses to assign a too remote antiquity for the destruction of moas. He recognises also that the Maori traditions contain some allusions to these birds. In his infancy he heard of moa-feathers being found on a rock where the last of these brevipennates had hidden itself. Nevertheless he also thinks that perhaps they were cassowary-feathers brought to New Zealand by the ancestors of the Maoris.(71) We observe that Mr. Stack does not consider the latter as descendants of the autochthonous moa-hunters, as contended for by Dr. Haast.

On this last point, besides, the opinions of the New Zealand geologist appear to have remained stationary. I have reproduced above the terms employed by Dr. Haast in the conclusions of his third memoir. I briefly pointed out all that seemed vague and contradictory about them, in spite of their apparent precision.(72) In another paper he expresses a very different opinion, and considers the Melanesian negroes as having preceded the Maoris in New Zealand, and attributes to them the extermination of the moa.(73) In support of this new theory he appeals to these very same traditions which he had rejected before in the most positive manner, and which he only became acquainted with through the Rev. Richard Taylor's work. It is from the latter that he borrows a quotation of Sir George Grey's, whose classical work he does not appear to have read.(74) Finally, in his "Geology of the Province of Canterbury," he distinctly adopts Mr. Colenso's views, and at different times he speaks of the predecessors of the Maoris as autochthonous natives, having lived in the Quaternary period. At the same time he admits that these children of the New Zealand soil had more or less close affinities with the Melanesians.(75)

I have too often combated this old idea of the autochthonism to make it necessary to refer to it again here. But quite apart from this question I shall be happy to enter the lists with Dr. Haast. The opinions held by him relative to

(70.) "An Account of some Enormous Fossil Bones of an Unknown Species of the Class *Aves*, lately discovered in New Zealand" ("Annals and Magazine of Natural History," 1844).

(71.) "Notes on Moas and Moa-hunters" (Transactions, vol. iv., p. 108).

(72.) See notes at the foot of the page.

(73.) "Notes on an Ancient Native Burial-place" (Transactions, vol. vii., p. 91). Haast, later on, insisted on this idea, and sought to show, by what happens in Australia, that very inferior black tribes are familiar with the process of polishing stone ("Geology of the Provinces," &c., ch. xvi., p. 411).

(74.) "Polynesian Mythology."

(75.) "Geology," first proposition, p. 430.

the existence of two races who inhabited New Zealand before the arrival of Europeans, and upon the nature of these two races, are well founded. Melanesian negroes did, in fact, occupy New Zealand before the Maoris. On this point the craniological observations have confirmed what I wrote eleven years before the publication of Dr. Haast's memoirs.(76) But this ethnical duality of New Zealand populations in no way involves as a consequence the destruction of the moa by the first occupants. In Europe the people of the Stone Age did not exterminate the reindeer, the chamois, nor yet the urus.

To maintain his opinion, and to throw back the extinction of moas into a past which, he says, cannot be calculated even by hundreds of years,(77) Haast does not fail to appeal to the results of his excavations in the Sumner Cave. He describes the cave as enclosing two beds, which, according to him, are entirely distinct. In the lower stratum the ovens were found to contain numerous moa-bones, which must have been the remains of the Melanesian feasts. The higher stratum, he affirms, only contained the shells of various mollusca, which had been eaten by other natives, who were the ancestors of the existing Maoris. Mr. McKay, member of the Geological Survey, who aided Dr. Haast in his researches, has published on his part a paper in which he professes almost the same opinions as his chief.(78)

But the difference on which so much stress is laid by Messrs. Haast and McKay, even if clearly proved, does not occur elsewhere. In several places an intermixture of shells and moa-bones has been met with. Moreover, the locality studied first by these geologists was explored later on by Captain Hutton and Mr. Booth, who had long been familiar with researches of this kind. Thus the facts established by them contradict in the most decided manner, and on several different points, the reports of the first explorers. Hutton and Booth have most often found moa-bones associated with beds of shells; they have proved over and over again that beds with

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(76.) A. de Quatrefages, "Les Polynésiens et leurs Migrations" (*Revue des Deux-Mondes*, February, 1864). These articles, amplified, and accompanied by notes and four maps, were later on incorporated in one volume, which appeared under the same title. A. de Quatrefages and E. Hamy ("Crania ethnica," p. 291). Among other proofs of the presence of two races in New Zealand, the Museum possesses a dried head of a Maori chief, whose origin is attested by the tattoo-marks, and whose hair is that of a pure Melanesian. I had it engraved in a book which I mentioned some way back ("Hommes Fossiles et Hommes Sauvages," pp. 486 and 487, figs. 171 and 172).

(77.) *Loc. cit.* (Transactions, vol. vii., p. 81).

(78.) "On the Identity of the Moa-hunters with the Present Maori Race" (Transactions, vol. vii., p. 98).

bones and beds without bones often overlay each other, sometimes one, sometimes the other, being uppermost.(79) The increasing scarcity of moas at a certain period, the migration of the people in consequence, the fortuitous association of two kinds of food at the same feast, the necessity of having recourse to a food which up till then had been disdained, explain in the most simple manner the difference of the results furnished by excavations made in neighbouring localities by equally competent explorers. But it is evident that the general result was irreconcilable with Dr. Haast's interpretation.

V.

Among the various propositions that Dr. Haast has maintained, that which touches on the history of the dog must arrest our attention. We have seen that in his third memoir he admits the existence of a wild dog cotemporary with *Dinornis*, and denies absolutely that the moa-hunters had possessed domestic dogs.(80) On this last point the learned New-Zealander is far from being consistent with himself. In his earlier researches he had only found a few dog-bones amongst the remains of feasts, and he explained this scarcity by saying that this animal was only occasionally eaten—when, for instance, the owner was short of provisions.(81) Here, therefore, he acknowledged that the domestication of the dog was customary with the moa-hunters. He added, it is true, that perhaps they were also hunted as game, which supposes that this animal lived in a wild state; and it is at this last opinion that he seems to have stopped short.

But, if this hypothesis were the true one, there would have been found, at some time or another, the bones of the dog associated with those of *Dinornis*, his cotemporaries. But we have said already that no land-mammal fossils have yet been met with in New Zealand.(82) The dog is no excep-

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(79.) Moa-bones were never found unassociated with beds of shells; and, although shell-beds did occur without moa-bones, these just as often underlaid beds with moa-bones as overlaid them ("Notes on the Maori Cooking-places at the Mouth of the Shag River," by Captain F. W. Hutton, Transactions, vol. viii., p. 105).

(80.) Fourth and fifth propositions.

(81.) "Either when its owner was short of provisions, or perhaps . . . ." ("Address," *loc. cit.*, p. 89).

(82.) In an early article on the moas, speaking of the small number of mammals found in New Zealand, and of the absence of fossils of animals of this class, I forgot to add the epithet "terrestrial." The reader probably filled up the gap. Fossil remains of cetaceous and other *aquatic mammals* have been found from time to time in New Zealand. (Haast, "Geology," &c., chs. x. and xi.) I mentioned elsewhere that the cetaceans play a part in the Maori traditions ("Polynésiens et leurs Migrations," ch. iv.), and that all animals of this kind cast up on the shore belonged

tion.(83) In fact, the bones of this animal have only been found in the ancient kitchen-middens, or among the *débris* scattered around these primitive ovens. But there, contrary to what Dr. Haast says, they are found in abundance. I can think of scarcely any explorer who has not recorded their existence, and they are always associated with moa-bones.

Here, however, a fact presents itself which seems singular at first sight, and upon which the learned New-Zealander has insisted at different times. The bones of all kinds lying about in the neighbourhood of the ovens are only very rarely gnawed.(84) Haast inferred from that that the moa-hunters were not accompanied by dogs; for these latter, he says, would not have refrained from attacking the remains of their masters' feasts. But in expressing himself thus he forgets that the canine race taken to New Zealand was primarily intended to furnish food and clothing.(85) The Maori dog, which came from the islands of Manaia, belonged to this Polynesian race, which all travellers describe as being vegetarian, and must have retained its natural habits in New Zealand.(86) Besides, if the dogs had taken to eating meat, their masters would have quickly discovered that this food affected in anything but an agreeable manner the flavour of their flesh, and they would not have failed to guard the observance of the habitual course.(87) It is quite natural, therefore, that the

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by right to the *ariki* or chief of the territory (*Journal des Savants*, January, 1873).

(83.) Captain Rowan has discovered the skeleton of a dog in the hollow trunk of a tree in the bed of a river near the sea-coast. This tree was at a depth of 18ft. and underneath a bed of lignite. Beside the bones were found the hair of the animal, fibres of phormium, and a stalk of the same plant. It is evident that the body had been carried into this hollow by some overflow of the river, and that this event was of modern origin. That is Dr. Hector's view of the matter. This scientist adds that the circumstances under which these remains were found tend to refer them to a period further back than any previously obtained. ("On the Remains of a Dog found by Captain Rowan near White Cliffs, Taranaki," Transactions, vol. ix., p. 243.)

(84.) The only fact of this kind that I have seen mentioned in the different memoirs written by the New Zealand scientists is that recorded by Hutton. Two moa-bones collected by his collaborator, Mr. Booth, near the ovens of the Shag River, had been gnawed by dogs. (*Loc. cit.*, Transactions, vol. viii., p. 106.)

(85.) "They are carrying some dogs with them, as these would be very valuable in the islands they were going to, for supplying by their increase a good article of food and skins for warm cloaks" (Sir George Grey, "Polynesian Mythology," p. 214).

(86.) The dog was called *kuri* by the Maoris. This local race was small in size, of a brown or yellowish colour, long ears, and bushy tails. It is extinct now, and replaced by the European dog.

(87.) The flesh of our European dogs, who all, more or less, eat meat, has a particular flavour, reminding one of the odour of a badly-kept kennel, as was only too well known during the siege of Paris.

Maori dogs did not behave like those which accompanied the old Danes of the *kjœkkenmœddings,* and that they did not leave, as these latter did, the trace of their teeth on the refuse bones around them.

VI.

Here, again, is a most important question in relation to which Dr. Haast disagrees with several of his colleagues. The eminent geologist has often declared that he has never found human bones amongst the scattered remains of feasts in the vicinity of the ovens; and from this negative evidence he concludes that the moa-hunters were not cannibals.(88) But he himself declares that he was unable to find any more in the heaps of shells which were unquestionably left by the ancient Maoris.(89) Moreover, the cannibalism of these latter is well known; and yet Dr. Haast's manner of reasoning would induce us to doubt it, and even to deny it. This simple remark destroys the entire value of Dr. Haast's argument. Besides, in both cases this absence of human remains is very easily understood. It is not when hunting, or when fishing peaceably for shells, that the most cannibal of the tribes regales itself on human flesh. To perpetrate an act of cannibalism under such conditions, and to leave the ground strewn with bones of men and moas, needed nothing less than some absolutely exceptional cause.

But, for all that Dr. Haast said, this occurred from time to time. Mr. W. Mantell was the first to establish this fact in the North Island,(90) and his statements are amongst those that cannot be doubted. This talented and persevering explorer discovered in the Wanganui Valley small mounds covered with grass, which the natives declared were formed by the remains of their ancestors' feasts. In digging them out he found that they were composed of moa-bones, dog-bones, and human bones mingled in confusion. All these bones had evidently suffered from the action of fire. Dr. Mantell (the father) tells us, moreover, that Mr. Taylor had come across similar mounds in the Whaingaehu Valley. These observations are not without corroboration. Mr. Thorne discovered in the northern part of the North Island, at the Pataua River, near Whangarei, alongside of remains of ancient Maori ovens, a medley of shells, cinders, coals, and bones of seals,

(88.) Seventh proposition.
(89.) *Loc. cit.*, Transactions, vol. viii., p. 74.
(90.) "These consisted of moas', dogs', and human bones promiscuously intermingled" ("On the Fossil Remains of Birds collected in Various Parts of New Zealand by Walter Mantell," by G. Algernon Mantell, Esq., F.R.S.: "The Quarterly Journal of the Geological Society," vol. iv., 1848, p. 234).

fish, men, and moas, having evidently formed a native feast.(91) Mr. Roberts also has found human bones mingled with moa-bones and cinders, close to stones which had evidently been used for the purpose of cooking them.(92) Finally, Mr. Robson has made similar observations in the neighbourhood of Cape Campbell.(93) Thus, contrary to the assumptions of Dr. Haast, the moa-hunters were cannibals.

VII.

I have just examined Haast's principal propositions which more directly bear upon the special question, the subject of the present inquiry. They are hardly consistent, as may be seen, with the actual facts which are beyond question. The same is true with respect to what he alleges as to the absence of local tradition relating to the moas.(94) As far back as 1848 Dr. Mantell announced to the Geological Society of London that his son had found near Wellington distinct traces of these birds which were of higher stature than a man, and were at one time very abundant in the country; and, further, that some of the oldest Maoris affirmed that they had seen them.(95) Later on, in 1870, Sir George Grey, in reply to an early paper by Dr. Haast, wrote a letter to the Zoological Society of London in which he declared that twenty-five years previously—that is, about 1845—the natives always spoke to him of the moas as having been known to their ancestors. He added that the Maori poems contain numerous allusions to these birds.(96) In 1875 Mr. Hamilton published the report of a conversation which he had had with an old native, who said he had seen the last of the moas, and who described it in a manner which was vividly impressed on the mind of his English questioner.(97) This Maori described, among other things, the curve of the neck with an exactness which could have been diagnosed by a well-informed European, but which nothing short of the actual appearance of the living animal could have suggested to the mind of a savage. I could multiply instances, but I shall

(91.) "Notes on the Discovery of Moa and Moa-hunters' Remains at Pataua River, near Whangarei," by G. Thorne (Transactions, vol. viii. p. 85, pl. iii.).

(92.) "Notes on some Ancient Aboriginal Caves near Wanganui," by H. C. Field (Transactions, vol. ix., p. 220).

(93.) "Further Notes on Moa-remains," by C. H. Robson (Transactions, &c., vol. ix., p. 279).

(94.) Second proposition.

(95.) *Loc. cit.*, p. 26.

(96.) Letter from Sir George Grey, quoted by Dr. Haast in his "Address," p. 100.

(97.) "Notes on Maori Traditions of the Moa," by J. W. Hamilton (Transactions, vol. vii., p. 121).

limit myself to quoting a few particulars given to Mr. Travers by Mr. White in the letters which I have referred to above.(98) We have already seen, and it will be still more evident, that, far from being vague and obscure, these traditions are remarkably precise.

"The Maoris," writes Mr. White, "as a rule, were afraid of it, as a kick from the foot of one would break the bones of the most powerful brave;(99) hence the people made strong spears of maire or manuka wood, 6ft. or 8ft. long, and the sharp end of which was cut so that it might break and leave about 6in. or 8in. of the spear in the bird.(100) With these the men would hide behind the scrub on the side of the track, and when the birds were escaping, from the fear of the noise of those who had driven them from the lakes, those spears were thrown at them, thus sticking in the bird; the scrub on the sides of the track would catch the spears, and break the jagged end off, leaving it in the bird. As it had to pass many men, the broken spear-points thus put into the bird caused it to yield in power when it had gained the open fern-country, where it was attacked in its feeble condition by the most daring of the tribe. When taken it was cut up with the stone *tuhua waiapu* (obsidian, flint).(101) The hunters carry with them a block of *tuhua*, and as it is chipped off and used it is not used again for any other bird or anything else, but left at the spot where used."

Before preparing themselves for the moa-hunt the Maoris went through one of the incantations or prayers which with them preceded all important acts. Mr. White could not recall exactly the terms, but he gives the sense of one of them: "The mists of the hills(102) most cele-

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(98.) Transactions, vol. viii., p. 79.

(99.) Mr. Travers adds in a note that a hill on the East Coast, called Karanga na Hape, is said to derive its name from the circumstance that Hape, a chief of the Arawa, pursued a wounded moa up the hillside and attacked it with a *taiaha*, when the bird kicked him and broke his thigh, and he rolled down the hill. Thus it is shown how all these popular traditions accord with each other.

(100.) The Maoris, like all the Polynesians, ignored or despised the use of the bow.

(101.) Mr. White tells us that the Maoris distinguished three kinds of obsidian, characterized by the colour. That which was used to cut off moas' flesh was of a light colour; another, a grey one, *tuhua aneto*, was used by the natives for gashing themselves in their funeral ceremonies. If the body was that of a chief or a child, the third kind, *tuhua kahurangi*, which is red, was used.

(102.) Contrary to the statements so constantly put forward, the Maoris had a very intricate mythology, and a very numerous, although perhaps not so well classified as that of the Tahitian (see Mœrenhout, "Voyage aux Îles du Grand Océan"). Every day the publications of New Zealand scientists prove the truth of this. The natives,

brated in the locality of the hunt are invoked to make the birds' fat flow as the globules of dew that run down the leaves of the trees at dawn on a summer's day, and the God of Silence is cautioned not to allow fear or dread to come near the moa." "The last moa-hunt known or remembered was in the North Island, at or near Whakatane, in the Bay of Plenty.(103) The feathers of the birds killed there were till a late period in the possession of a chief called Apanui."(104) Several material facts prove the truth of the account given by Mr. White. Thus, all the memoirs recording the researches made near the old moa-ovens speak of flakes of obsidian which had evidently been used for cutting up these birds: all of them refer to the great number and the similarity of these primitive knives. Mr. Thorne has, moreover, found one of the blocks of obsidian carried by the Maoris to meet their requirements, and recognised by the abundance of chips the precise spot where for the time being they manufactured these flakes.(105) On the other hand, Dr. Hector discovered on an elevated plateau near Jackson's Bay, at an altitude of 4,000ft. numerous paths intersecting the thick scrub. These paths were not formed by man; they were well beaten, and about 16in. wide. They were, in fact, *tracks* such as are made by wild animals. In New Zealand they were evidently the work of birds. Owing to the height of the scrub they could only have been made by animals much larger than the *Apteryx*, which alone frequented them at the time of Dr. Hector's visit, the imported mammals not yet having penetrated so far.(106) Do not these paths correspond perfectly with the idea one forms of those used by the moa-hunters when

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among other things, believed in innumerable kinds of sprites, gnomes, or fairies, and to which they attributed the greater part of what happened to them, whether good or bad. Thus it was necessary to be constantly propitiating them. Hence arose the multitude of prayers and incantations which are so frequently spoken of in Maori traditions. On all these questions those who ought chiefly to be consulted are the following: Grey, "Polynesian Mythology;" Rev. J. F. Wohlers, "Mythology and Traditions of the Maoris" (Transactions of New Zealand Institute, vol. viii., p. 108); Colenso, "Historical Incidents and Traditions of the Olden Times, now for the First Time faithfully translated from old Maori Writings and Recitals" (*id.*, vol. xiii., p. 38, and vol. xiv., p. 3); Colenso, "Contributions towards a Better Knowledge of the Maori Race" (*id.*, p. 33); and Rev. R. Taylor, "Te Ika a Maui; or, New Zealand and its Inhabitants."

(103.) Bay of Plenty.

(104.) Mr. White adds the name of another known individual, and enters into details unnecessary for reproduction here.

(105.) *Loc. cit.*, p. 86.

(106.) "On Recent Moa-remains in New Zealand," by J. Hector, M.D., F.R.S. (Transactions, vol. iv., p. 119). Dr. Hector's visit to these mountains took place in 1863.

laying their ambuscades? and does not their state of preservation attest the fact that they could not have been unused for centuries?

VIII.

But the most decisive proof in favour of the recent disappearance of the moa is furnished by the discoveries, made from time to time, of bones with fragments of flesh, muscles, and integuments still adhering to them. No less than three such discoveries have been made. The Colonial Museum possesses a portion of the neck, but whence it came I have never yet heard.(107) In 1871 Mr. Low informed Dr. Hector that he had just been given a piece of moa-flesh, covered with fluff and numerous quill-tubes.(108) About the same time Dr. Thompson obtained from a gold-digger, who had discovered them in a cave under a heap of mica-schist, the bones of a moa to which still adhered the ligaments, muscles, and shreds of skin. The portion of the neck to which I have just alluded was part of this find, and was forwarded to Dr. Hector, who figured it and described it with great fidelity.(109)

In these various pieces the tissues do not seem to have undergone any alteration; they are simply shrivelled. The flesh is no way fossilised, and the fibres were easily detached.(110) Dr. Millen Coughtrey, to whom Dr. Thompson sent the specimens which he had collected, made an anatomical examination of the neck, and was able to distinguish the different muscles; on the right femur he found the fibres and tendons of nine muscles. The other bones only showed the remains of tendons.(111)

In answer to the objections against his theory furnished by the foregoing facts, Dr. Haast affirms that the neck-bones described by Dr. Hector are in a state of semi-fossilisation, similar to that of the greater part of moa-bones. He ascribes the existence of muscles and integuments to their accidental position in a bed of dry sand.(112) But how are we to understand that the bones could become fossilised whilst the flesh remained intact? Besides, on the first point the learned geologist is plainly contradicted by Dr. Hector, who repre-

(107.) Haast, "Third Paper," *loc. cit.*, p. 102.

(108.) Note added to Dr. Hector's memoir, p. 114.

(109.) "On Recent Moa-remains in New Zealand" (Transactions, vol. iv., p. 111, and pl. v.).

(110.) Low, *loc. cit.*

(111.) "Notes on the Anatomy of the Moa-remains found at Earnscleugh Cave," by Millen Coughtrey (Transactions, vol. vii., p. 141). To judge by the details given by Mr. Thomson all the muscles and integuments which this cave contained have not yet been collected. See Dr. Hector's memoir, *loc. cit.*, p. 112.

(112.) "Additional Notes," p. 93; "Third Paper," p. 102.

sents these same neck-bones as being in a state of perfect preservation, and not in the least mineralised.(113) Mr. Low affirms the same thing of the specimens which came into his possession. How can we doubt the accuracy of this account, seeing that the muscles adhering to these bones were capable of being dissected? Dr. Haast replies, it is true, to observations of this kind, that in Europe bones dating from the Quaternary epoch have sometimes shown a remarkable degree of preservation. He quotes particularly the facts established by Messrs. De Ferry and Arcelin at Clos-du-Charnier, where the bones and horns of the reindeer had retained the greater part of their gelatine;(114) but he forgets that none of these bones have ever shown the least trace of muscles or tendons. At Solutré, as in every other place where fossil bones have been collected, the fleshy parts have entirely disappeared.

It is just the preservation of the latter that gives to the moa-remains studied by Dr. Hector their great historical significance. It is, however, evident that there must have been some exceptionally favourable circumstances so that a portion of muscular and cutaneous tissue had escaped destruction, whilst the greater part had disappeared. But it seems to me impossible to imagine a combination of physical circumstances capable of preserving the tissues during centuries under the conditions inseparable from the insular position of New Zealand.(115)

Thus all things concur to prove the final extinction of moas as having taken place at a not distant period. There is consequently no difficulty in accepting as true the information collected by Sir George Grey and Messrs. Mantell, White, and Hamilton. On the contrary, in admitting that some of the large brevipennate birds still lived about a century ago, one easily explains several well-established facts quite incompatible with Dr. Haast's theory, such as the existence of tracks still quite discernible, the preservation of the shreds of

(113.) "Without being in the least degree mineralised" (*loc. cit.*, p. 114).

(114.) "L'Age du Renne en Maconnais" (International Congress of Prehistoric Archæology, 1868); quoted by Dr. Haast, "Geology," p. 442).

(115.) Such is also the opinion of M. Alphonse Edwards, whose authority is unquestionable, in consequence of his position at the Museum and his studies on fossil birds. This is what he was kind enough to write to me on the subject: "Dr. Haast ('Geology,' &c.) recalls in aid of his theory the discoveries made in Siberia of entire bodies of mammoths, whose deaths took place in the Quaternary period. I do not share Dr. Haast's opinion on this point, for, if these animals can be preserved indefinitely in the frozen soil of Asia, it is not so in New Zealand, where, since the prehistoric times, the temperature has been very mild and the humidity considerable. These conditions ought to facilitate the putrefaction of bodies, whatever may have been the natural conditions of burial."

flesh and skin, &c. Moreover, the information collected by Mr. Hamilton seemed to relate to the same period. Haumatangi, the old Maori of whom he speaks, was one of the oldest of his race in 1844. He said he had seen Cook.(116) We know that this illustrious sailor rediscovered New Zealand—which had been almost forgotten since Tasman's discovery—on the 6th October, 1769. Haumatangi was consequently more than seventy-five years old when Mr. Hamilton questioned him, and not seventy only, as some printer's error makes it appear. Supposing that he was twelve years old when he observed the large bird which he remembers so well, New Zealand would still have possessed living moas towards 1770 or 1780.

IX.

I regret having been compelled up to this point to controvert Dr. Haast's theory. I am only too glad now to acknowledge the incontestable services which he has rendered to science in solving some of the most interesting questions which the history of the moas has given rise to. The result of his persevering and successful researches is that all the large and small brevipennates which have inhabited, and still inhabit, New Zealand were found to have been cotemporary. In exploring the alluvial deposits and the swamps at Glenmark the learned geologist found side by side bones of *Apteryx*, as well as the remains of larger and more singular species of moa, just as we find in Europe bones of mammoths and rhinoceri intermingled with those of the reindeer and chamois.(117)

In our country also the disappearance of now extinct species did not occur at the same time. If there were some that survived until the end of the eighteenth century, others had perished at an epoch more or less remote. New researches, of a kind up to this time too much neglected by New Zealand scientists, will be necessary to give a precise idea of these successive disappearances. In order to solve the numerous questions raised by this problem archæology and geology should help each other. Dr. Haast seems to me to be the

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(116.) Dr. Haast quotes, in favour of his opinion, Cook's silence with regard to moas; but it is evident that at that time they were very nearly extinct. Now, as all the coasts were inhabited, the last of these birds would no longer have been found except in the interior, and it is very natural that the great English navigator should have heard nothing of them. The same remark applies *a fortiori* to the explorers who came after Cook, and whose silence is likewise adduced by Dr. Haast in support of his theory ("Geology," &c., ch. xvi.).

(117.) "Geology," Glenmark, ch. xvi. (*d*), p. 442. Dr. Haast estimates at more than a thousand the number of moas whose remains had been found in this locality. It is from there had come the greater part of the specimens which enrich museums in all parts of the world.

only one who has already collected some data of this kind, and we ought to be grateful to him.(118)

The information published by him shows that the bones of *Dinornis giganteus* have never been found among the remains of feasts in the neighbourhood of the ancient ovens. The largest of the birds seems therefore to have been extinct before the arrival of man in New Zealand. Dr. Haast only once found the remains of a *Dinornis robustus* in the kitchen-middens. This latter species, somewhat smaller than the former, had probably almost disappeared when the hunters killed one of its last representatives at Shag Valley. At Rakaia the remains of three *Palapteryx ingens* were found, the bones of which had been intentionally broken; but this bird has not been encountered elsewhere. The *Palapteryx crassus* shows itself very abundantly at Shag Valley and at Rakaia. *Palapteryx elephantopus* has been found in the same two localities, but in less quantities than the preceding ones.

It is therefore noticeable that man has eaten some of the largest and most remarkable species of moa. Moreover, he seems to have exterminated them in a very short time. None of those which I have just mentioned were to be found at Point Cave. They are replaced by the *Euryapteryx* and the *Meionornis*, especially by the *Meionornis didiformis*, which the natives—although they sometimes killed it—seem to have passed by so long as they could hunt *Palapteryx*.(119) I put here in a tabular form the results of the researches made by Dr. Haast in some of the localities where man fed on the moa, adding the indications given by the author of the greater or less abundance of bones belonging to the different species.

Genus Dinornis.

D. robustus (Shag Valley, a few bones).
D. gracilis (Rakaia, prevailing).
D. struthioides (Rakaia, prevailing).

Genus Palapteryx.

P. ingens (Rakaia, three skeletons).
P. crassus (Shag Valley, prevailing; Rakaia, plentiful).
P. elephantopus (Shag Valley, less; Rakaia, few).

Genus Meionornis.

M. casuarinus (Shag Valley, very few; Rakaia, prevailing; Point Cave, 15·05).
M. didiformis (Shag Valley, very few; Rakaia, numerous; Point Cave, 53·03).

(118.) "Address," p. 86; "Third Paper," p. 97; "Researches in Sumner Moa-cave," p. 85; "On a Moa Encampment," p. 99.
(119.) Letter from Mr. W. H. G. Roberts (Transactions, vol. vii., p. 548).

Genus Euryapteryx.

E. rheides (Shag Valley, prevailing; Point Cave, 49·01).
E. gravis (Shag Valley, few; Point Cave, 33·03).

Thus, about two-thirds of the known species of moas have been found in the *débris* of the native feasts.

If the Maoris had hunted the moas only according to the modes described by Mr. White, it is very probable that Europeans would have been able to see some species of the large brevipennates. But they employed much more effective means. They placed slip-knots in the moa's path, running into which the birds were snared.(120) They also organized large hunting-parties in which the whole population acted as beaters. The birds were driven into a lake, where hunters, in canoes, killed them without difficulty.(121) Finally they went as far as to set fire to vast tracts of forest, in which the birds must have perished in hundreds, and often, no doubt, without any profit to those who lighted the fires. Thus is explained the fact mentioned by Mr. Taylor and many other writers, who speak of extensive areas covered with little mounds composed of moa-bones.(122) It ought to be mentioned that the Maoris were rather fond of the eggs, as almost everywhere there have been found immense numbers of broken egg-shells.

Thus hunted down and prevented from reproducing themselves, the moas were bound to disappear. But their extinction is certainly recent. In arguing to the contrary—in contending that the total destruction of these large birds goes back to an epoch as ancient as our European Neolithic times—Dr. Haast was mistaken. He has been carried away by analogies of a purely geological character, perhaps more apparent than real.

In any case, one would not be able to establish a true parallel between the zoological facts presented in Europe and in New Zealand. The New Zealand Quaternary fauna was altogether of local origin. It is different with us. The mammoth and the rhinoceros were emigrants which had been driven by the cold of the northern regions of Asia towards warmer countries.(123) The extinction of these species must have been hastened by circumstances quite different from those

(120.) Rev. Mr. Taylor, quoted by Mr. Travers (Transactions, vol. viii., p. 77).

(121) Roberts, *loc. cit.*

(122.) Taylor, *loc. cit.*

(123.) Murchison, De Verneuil, Keyserlink, and D'Archiac regard the mammoth and the rhinoceros with divided nostrils as having lived in Siberia in the Tertiary epoch. According to Lartète the reindeer was their contemporary.

of their native country, and by the severe changes of climate which they had to submit to towards the end of the glacial period. Nothing of the kind happened in New Zealand. There the moas were really indigenous; they never quitted their centre of original creation; they only underwent the slightest modifications in their conditions of existence, as Dr. Haast himself plainly shows.(124)

The natural extinction of these birds is consequently difficult to understand. However, it must be admitted that physical causes opposed themselves to the indefinite survival of certain species. To judge by the known facts, it seems proved that the largest *Dinornis* no longer existed when man reached these insular lands in the midst of the ocean. The other species of the same genus, and the *Palapteryx*, appear to have been scarce from that period, and not to have long survived the advent of the moa-hunters. A natural decay was then in operation. The *Meionornis* and the *Euryapteryx* seem, on the contrary, to have been very numerous prior to the time when the war of extermination was carried on with so much recklessness.(125)

In consequence of geographical conditions, they could not migrate like the reindeer, and their manner of life prevented them from going to seek a retreat in the centre of glaciers, as the chamois has done in Europe. They were therefore exterminated—but only recently, like the dodo and other birds belonging to the Mascarene Islands, the history of which M. Milne-Edwards has restored and completed.(126)

P.S.(127)—It seemed to me that it would be interesting for those who are well up in the subject to be informed of a document which brings fresh evidence in favour of the opinion which I have always upheld. I am indebted for it to the well-known ornithologist Sir Walter Buller, who kindly communicated to me a copy of the *New Zealand Times* of the 1st November, 1888. At a meeting of the Philosophical Society

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(124.) "Address," *loc. cit.*, and "Geology," *passim.*

(125.) Here are, according to Haast, the proportions in which the different species of moa are represented at Glenmark: The *Meionornis casuarinus* alone represents a quarter, and the *M. didiformis* a fifth, of the total number of individuals discovered; afterwards, in decreasing numbers, the *Palapteryx elephantopus*, *Euryapteryx gravis*, *P. crassus*, *Euryapteryx rheides;* the *Dinornis gracilis*, *struthioides*, *maximus*, and *robustus* are about equal in number; the *D. ingens* is only represented by a small number of individuals.

(126.) "Recherches sur la Faune Ornithologique Éteinte des Îles Mascareignes et de Madagascar," by M. Alphonse Milne-Edwards; 1866–1879.

(127.) "Nouvelle Preuve de l'Extinction Récente des Moas" (*Le Naturaliste*, No. 53, May 15, 1889, p. 117), by M. A. de Quatrefages.

Colonel McDonnell informs us generally of an incident which he witnessed himself in 1866 in the north-west part of the North Island: "Sir George Grey, then Governor of New Zealand, was at the time visiting this locality; and an old Maori called Kawana Paipai told him that when a young man he had often joined in moa-hunts with his countrymen on the Waimate Plains. He described the way in which the hunt was conducted. When a certain number of young men had discovered a moa they pursued it till they were exhausted. Another party then took their place, and so on. When the moa got tired they killed it with stones or sticks. Some doubt having been expressed about Paipai's testimony, he got very angry, and said that if a few men were sent with him, and brought picks along with them, he would show them where moa-bones could be found in the ancient ovens. So it was done; and accordingly moa-bones were found 3ft. deep among ancient ovens. Kawana added that when the moas were hunted down they fought with great fury, striking with their feet." Colonel McDonnell calculated that this hunt must have taken place at the beginning of this century. It is therefore clear that, far from being too bold, I had under-estimated the time of the disappearance of the moa in carrying it back so far as the end of the last century.

ART. VI.—*Note on* Mus maorium *(Hutton), with Exhibition of Specimen.*

By Sir WALTER L. BULLER, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 5th October, 1892.*]

I HAVE much pleasure in exhibiting this evening a specimen of the true Maori rat (*Mus maorium*), about which there has been from time to time much discussion in the pages of our Transactions. This example came from Nelson, where it was obtained at the time of the great irruption of rats into that district so fully recorded by Mr. Meeson and other local observers. It is identical with the species of rat collected by Mr. Reischek some years ago on the Little Barrier and other islands in the Hauraki Gulf, specimens of which were taken by me to England in 1886. I compared these with specimens sent to the British Museum by H.E. Sir George Grey about the year 1848, and found the rat to be the same. Mr. Oldfield Thomas, of the Zoological Department, who assisted me in this examination and comparison, is of opinion that the species is identical with the Polynesian rat (*Mus exulans*)

(Peale, Expl. Exped.). This form is known to have a wide range, there being specimens in the British Museum from the Fiji Islands, from Norfolk Island, and from New Caledonia.

Mr. Oldfield Thomas told me that he had fully satisfied himself, by a comparison of the skull and other bones, of the identity of Professor Hutton's *Mus maorium* (described from fossil remains) with the rat now before you.

Art. VII.—*Note on the Bats of New Zealand.*

By Sir Walter L. Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 26th October, 1892.*]

As there has hitherto been some confusion in the nomenclature of the two species of bat inhabiting New Zealand, I think it would be well to place on record in our Transactions the following remarks on the subject by Mr. Oldfield Thomas, of the British Museum, as contributed to the "Annals and Magazine of Natural History" for December, 1889:—

"It has always been a subject of regret that, owing to Gray's error in ascribing* to Forster's *Vespertilio tuberculatus* a specimen of the long-eared bat of New Zealand, which he then described and made the type of the genus *Mystacina*, the specific names of the two New Zealand bats should have been identical, an identity particularly inconvenient to writers on the fauna of that country. It is therefore with some pleasure that I am now able to point out that the names of the two species should, after all, not both be *tuberculatus*.

"The *Mystacina* unquestionably should bear that name; but in the case of the other species, referred in modern times to the genus *Chalinolobus*, the name *tuberculatus* has not the priority of *publication*, although dating in manuscript from the last century. It is now universally recognised that manuscript names do not confer priority, and before Forster's description of 1772–74 was published by Lichtenstein in 1844† a second name had been given to the bat by Dr. Gray, who described a specimen from South Australia as *Scotophilus morio*,‡ and under the latter short and convenient specific name the *Chalinolobus* should certainly stand.

"Instead, therefore, of *Chalinolobus tuberculatus* and *Mys-*

* Voy. "Sulphur," Mamm., p. 23 (1843).
† Forst. Descr. Anim., ed. Licht., p. 62 (1844).
‡ Gray's Austr., App. ii., p. 405 (1841).

tacina tuberculata, we shall have *Chalinolobus morio* and *Mystacina tuberculata* as the two bats of New Zealand, both of them being represented by their type specimens in the National Collection.

"In this connection it may be pointed out that *Chalinolobus signifer*, Dobs.,* from Queensland, is in all probability the same as *Ch. morio*, its distinguishing character—the transverse cutaneous lobule on the muzzle—being a mark of old age, especially developed in the male sex. and not of specific distinctness. A male specimen from one of the outlying islands round Stewart Island, New Zealand, recently presented to the Museum by Mr. Charles Traill, has this lobule quite as well marked as in the type of *Ch. signifer*, and all the other fully adult specimens of *Ch. morio* in the Museum show some trace of the same lobule, while in immature individuals no sign of it is present."

MEMO.—Since communicating the above to the Society, I have received an interesting letter from Mr. R. Caldwell, one of the District Surveyors, which I am anxious to place on record in our Transactions, because it so completely confirms the accounts which I have often received from the older Maoris that both of our species of bat live in communities inhabiting the cavernous interior of some dead and hollow tree, congregating there in hundreds or thousands, and clinging to the sides in successive tiers, packed so closely as to occupy the entire surface. Most unfortunately, in the instance mentioned by Mr. Caldwell the fire took possession of the tree, which was in a very dry and combustible state, and the whole colony perished in the conflagration. The numbers that escaped when their home was invaded would probably establish themselves in another similar situation on the same wooded range, which lies, I understand, about five miles to the westward of Carterton:—

"A fact that has come under my observation in connection with bats may interest you; I therefore take the liberty of sending you some particulars. I left Carterton, together with two companions, for a walk into the hills at the right-hand side of the Waiohine, going by way of the Belvedere Road. We got fairly into the hills about 10 a.m., and climbed a high range covered with black-birch. Getting warm, we sat down on the moss to rest. Then my attention was attracted by a smell of a kind I had not noticed in the bush before, and one that reminded me of a flying-fox camp in Queensland. I followed the smell for some distance to a large birch-tree with an opening about 4ft. from the ground. I had evidently traced the smell to its source, for at the opening it was fairly

* Ann. and Mag. Nat. Hist. [4], xvii., p. 289 (1876).

stifling. I could see nothing, so I lighted a bunch of dry leaves, and thrust it through the opening into the tree. As I did this a bat flew out in my face, another, and another. The smoke increased, and the bats streamed out in hundreds. I have no means of computing the number, but one of my men, having a small switch in his hand, kept striking at the stream, the result of which I afterwards counted. There were exactly a hundred bats killed. For one killed at least ten must have passed and flown away. Large numbers dropped down in clusters through the blazing opening. I had no idea there were so many bats in the Wairarapa, and would not have believed it had I not seen them. I have never seen in New Zealand such another collection."

Art. VIII.—*Note on the Flightless Rail of the Chatham Islands* (Cabalus modestus).

By Sir Walter L. Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 26th October, 1892.*]

I have much pleasure in exhibiting this evening two specimens (presumably male and female) of the Flightless Rail (*Cabalus modestus*), recently obtained on Mangare Island, a rocky satellite of the Chathams.

My correspondent informs me that this bird is strictly nocturnal in its habits, and that the man employed by him was out every night for two months before he succeeded in taking them.

The distinguishing superficial characters of this remarkable form are apparent at a glance: the abbreviated wings, the soft fluffy plumage of sombre hue, the long, slightly-curved bill, and the well-developed legs. Professor Hutton, who first described this species, claimed for it generic rank on account of its internal structure (Trans. N.Z. Inst., vol. vi., pp. 108–110), and this claim is now generally recognised. The curvature of the bill is more pronounced in the larger (presumably the male) bird, being very similar to that of the Moeriki (*Cabalus dieffenbachii*) as figured in our Transactions (vol. vi., p. 12), but more slender, and I feel confirmed in the opinion that the two species are referable to one and the same genus.

The specimens now before the meeting have enabled me to prepare a more detailed description of the species than has hitherto appeared.

Adult.—General plumage dark vinous-brown, changing to

dull-grey in the throat; foreneck, breast, and the rest of the under parts, as well as the sides of the body, marked with numerous narrow, transverse, broken bars of yellowish-brown; these markings continued, but in a fragmentary and scattered manner, on the upper surface of wings; on the bastard quills, and on the under tail-coverts they are broader, lighter, and more regular; quills blackish-brown, each vane crossed at regular intervals by triangular markings of fulvous-brown. Bill and feet uniform dark-brown.

The two specimens differ appreciably in size, and I take the smaller of the two to be the female, although the wing-markings are more conspicuous than in the larger one. In this latter the curve in the bill is very apparent.

Male.—Extreme length, 9in.; wing, from flexure, 3·2in.; tail, 1·6in.; bill, along the ridge 1·5in., along the edge of lower mandible 1·7in.; tarsus, 1·2in.; middle toe and claw, 1·5in.

Female.—Extreme length, 7·5in.; wing, from flexure, 3in.; tail, 1·5in.; bill, along the ridge 1·25in., along the edge of lower mandible 1·6in.; tarsus, 1in.; middle toe and claw, 1·4in.

In both specimens there is a minute spur at the flexure of each wing.

ART. IX.—*Notes on New Zealand Birds.*

By Sir WALTER L. BULLER, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 13th July, 1892.*]

Plates V., VI.

BEFORE proceeding to place before this meeting my customary budget of ornithological notes, I must take this opportunity of congratulating those who take an interest in the birds of New Zealand on the fact that, at the instance of the late Governor, it has been decided by the Government to set apart two suitable islands—the Little Barrier at the north and Resolution Island in the south—as public reserves for the conservation of the indigenous fauna and flora. His Excellency, in a memorandum of considerable length, which has lately been placed before the General Assembly, directs the attention of his Ministers to the fact that many of the native species, under the changed conditions of existence, are passing away; that some have already disappeared, whilst others are verging on extinction. He mentions that many prominent writers on zoological

science have urged the importance of some steps being taken for the conservation of New Zealand birds, and have pointed out that it will be a lasting reproach to the present generation of colonists if no attempt is made to save some—if only a remnant—of these expiring forms, for the student of the future. He quotes from Professor Newton's address to the Biological Section of the British Association, at Manchester, in 1887, as follows: "I would ask you to bear in mind that these indigenous species of New Zealand are, with scarcely an exception, peculiar to the country, and from every scientific point of view of the most instructive character. They supply a link with the past that once lost can never be recovered. It is therefore incumbent upon us to know all we can about them before they vanish. . . . The forms we are allowing to be killed off, being almost without exception ancient forms, are just those that will teach us more of the way in which life has spread over the globe than any other recent forms; and, for the sake of posterity, as well as to escape its reproach, we ought to learn all we can about them before they go hence and are no more seen." And, after putting forward many cogent reasons, His Excellency concludes his argument thus: "Looking to the interests involved—the great loss to the scientific world implied in the extermination of natural forms that do not exist elsewhere, and the importance therefore of saving them—it cannot be denied that a heavy responsibility rests on those who, while there is yet time and opportunity, may neglect to take the necessary steps for their preservation." The Hon. Mr. Ballance has earned the hearty thanks of every ornithologist by taking prompt action on Lord Onslow's recommendations, by setting apart the required island reserves, and by making arrangements for having them stocked with birds and plants from the mainland, and placed in charge of a competent ranger.

It is also a matter for congratulation that the present Government has, by Proclamation in the *New Zealand Gazette*, extended the provisions of the Wild Birds Protection Act to the Huia. It has been a frequent subject of complaint in the pages of our Transactions that this beautiful mountain starling was being indiscriminately destroyed by Maoris and pakehas alike, and that unless some measures were taken for its protection the species would soon disappear altogether. The appeal on behalf of this bird made by His Excellency, which has happily proved effective, is in the following words:—

"There is a bird famous in Maori history and poetry—remarkable for its singular beauty, and interesting to naturalists on account of its aberrant generic characters—a species confined to a very limited portion of the North Island, from which, owing to the eagerness of natural-history collectors

and the inevitable progress of settlement in its native woods, it is fast disappearing. I refer, of course, to the Huia (*Heteralocha acutirostris*), a bird which is naturally confined within such narrow geographical boundaries that I may describe its range as being limited to the Ruahine, Tararua, and Rimutaka Mountain-ranges, with their divergent spurs and the intervening wooded valleys. The white-tipped tail-feathers of this beautiful bird have been from time immemorial the chief adornment of Maori chiefs as head-plumes; and an incident connected therewith, in ancient times, led to the adoption of the name by the great ancestors of the Ngatihuia Tribe. As Ministers are aware, when selecting a Maori name for my infant son, to commemorate his New Zealand birth, I was induced, for several considerations, to give this name the preference over all others submitted to me; and I should therefore accept it as a compliment to my family if Ministers would exercise the power they possess, and throw over this bird the shield of Government protection. I ask this the more readily on the ground that I have been moved to do so by the chiefs of the Ngatihuia Tribe. At the public function at Otaki, on the 12th September last, when I had the pleasure of presenting my son to the assembled tribes, a number of very complimentary speeches were made by the leading chiefs, and one of them, in referring to the name, said, 'There, yonder, is the snow-clad Ruahine Range, the home of our favourite bird. We ask you, O Governor! to restrain the pakehas from shooting it, that when your boy grows up he may see the beautiful bird which bears his name.' The Huia loves the deep shade of the forest, and as its home is invaded by the settler's axe it would, if protected from reckless destruction, simply retire higher up the wooded ranges, till it finally took refuge in the permanent forest reserve, which embraces all the wooded mountain-tops within its natural domain. Under vigilant protection, therefore, the Huia would have every chance of being preserved and perpetuated."

I believe it is part of Mr. Ballance's scheme to acclimatise Huias on Resolution Island. As mentioned already, the natural range of this bird is a very limited one, but it includes the cold summits of several mountain-ranges, and it is not improbable, therefore, that the climate of Resolution Island will suit it very well. At any rate, the experiment is worth a trial, and will be watched with interest by scientists both here and at Home. The marvellous manner in which the birds brought from the South by Sir George Grey, and placed on his island home at Kawau, have increased and multiplied, affords ample proof that New Zealand birds, from whatever locality, will, under favourable conditions, thrive well anywhere.

As pointed out by Lord Onslow in his memorandum,

Resolution Island is already partially stocked, the Kiwi and the Kakapo being comparatively abundant there, whilst there is reason to believe that the rare *Notornis mantelli* (of which only three examples are known) still survives in the island. He also points out that on the Little Barrier Island the Stitch-bird (*Pogonornis cincta*) finds its last refuge, whilst the Bell-bird (*Anthornis melanura*), the Whitehead (*Clitonyx albicapilla*), and the Wood-robin (*Miro albifrons*), all of which have disappeared from the mainland, are comparatively plentiful there.

Sir James Hector, in a memorandum on the papers submitted to Parliament, suggests that the various acclimatisation societies might at this juncture give valuable aid, both in the way of collecting rare birds and undertaking the custody of the reserves. His opinion is that "if the Resolution Island Reserve were placed under the control of the Otago society, and the Little Barrier Island Reserve (when acquired) under the Auckland society, and in each case with a moderate subsidy contributed by Government, the work of conservation would be placed on a simple and efficient footing."

Glaucopis cinerea, Gmelin. (The South Island Crow.)

I had in my possession for many months a live Kokako from the South Island, kindly presented to me by Dr. Cahill. Although apparently in perfect health, it died at last in a fit, caused, I am inclined to think, by extreme fatness, the result of overfeeding without sufficient exercise. The bird was accustomed to occupy a large wire cage in my library, and was a very lively companion, being perpetually on the move and very musical. His period of chief activity was in the early morning or immediately before rain, when he would indulge at short intervals in a melancholy call in a high key, exactly like the Maori words "*Kowai-koe?*" (Who are you?). At other times it produced a short mellifluous whistle, and every now and then a liquid bell-note quite undistinguishable from the evening tolling of the tui. It occasionally, but not often, sounded the rich organ-note—short, but of surpassing sweetness—which I have described in my account of the North Island Crow ("Birds of New Zealand," i., p. 2). In addition to all this it has a soft note, in repetition very like the low whimper of the Huia, and, more rarely, a more exact simulation of a hollow cough than that of the Tui. I know nothing of the history of the bird before it came to me, or whether it was brought up from the nest or not, but I was often inclined to think that, as a caged bird, it had been exercising some natural power of mimicry. Its usual food consisted of cooked potato, boiled rice, and soaked bread, but it took *Coprosma* and other ripe berries with avidity, and seemed to relish all

kinds of green succulent leaves, holding them in its foot when feeding, after the manner of a parrot. He was fond of water, drinking freely, but rarely using it for bathing as other birds do. Nevertheless his plumage was always in a clean and silky condition. On presenting to him a large bluebottle fly, he held it to his perch in the manner described, deliberately tore off one wing and then the other, tasted its flavour, and immediately dropped it. I tried him with other insects, but always with the same result. It is obvious, therefore, that this bird is not insectivorous, which is somewhat singular, seeing how omnivorous the members of the Crow family generally are.

Heteralocha acutirostris, Gould. (The Huia.)

On page 17 of "The Birds of New Zealand" I have represented in a woodcut a very curious deformity in the bill of a Huia, in which the upper mandible had assumed the form of an erect corkscrew, like the spiral horn of the *Strepsiceros*. This specimen had been obtained in the Forty-mile Bush, and was minutely described afterwards by the Rev. W. Colenso, F.R.S., in our Transactions (vol. xix., pp. 140–145). Recently a specimen from the same district has been shown to me in which a still more singular malformation presents itself (see fig. 1, Plate V.). This bird, like the last-mentioned, is an adult female, in perfect plumage; and, whilst the lower mandible has retained its ordinary form and proportions (except being a little shorter than usual), the upper has assumed the form of a perfect circle, resembling an overgrown boar's tusk in miniature. The lower mandible is unaffected by this, except that at the point of contact its cutting-edge has an even notch or depression produced by the constant friction.

Myiomoira toitoi, Lesson. (The North Island Tomtit.)

I have to record another albino of this species from Wanganui. Body-plumage white, purest on the head, clouded with black on the sides of the neck, breast, and back; quills black with white tips; wing-coverts almost entirely white; innermost tail-feathers white with a grey shade, and the rest normal; bill and legs pale-yellow.

In Mr. Drew's collection at Wanganui there is a pure albino of this species, presenting not a single dark feather.

Miro traversi, Buller. (The Black Robin.)

I have received several more specimens of this bird from the Snares. The sexes appear to be absolutely alike in plumage.

Sphenœacus punctatus, Gray. (The Fern-bird.)

Professor Hutton sends me the following note: "Last year I sent a specimen of *Sphenœacus punctatus* to F. E. Beddard for dissection. He now writes to me, 'I find that it is quite a typical Acromyodian Passerine bird, and that the position assigned to it in Sharpe's Catalogue of Birds in the British Museum is quite in accordance with its anatomical structure.'"

Sphenœacus rufescens, Buller. (The Chatham Island Fern-bird.)

The Hon. Walter Rothschild writes informing me that in a collection of bird-skins recently received from the Chatham Islands there was a good series of this well-marked species.

Prosthemadera novæ-zealandiæ, Gmelin. (The Tui.)

An albino in Mr. Drew's collection has many of the quills in both wings, and the three middle tail-feathers, wholly or partially normal; most of the secondaries in one wing partially white; cloudy patches of black on the shoulders and on the abdomen, with a few scattered black feathers on the breast; the rest of the plumage pure-white; bill and feet normal.

Pogonornis cincta, Dubus. (The Stitch-bird.)

An Auckland collector has recently been on a visit to the Little Barrier Island for the purpose of getting specimens of this rare bird, several of which were obtained. This is the last refuge of the species, and unless the strong hand of the Government is invoked for its protection, and that at once, the Stitch-bird will soon be lost to us for ever. Let us hope that steps will be taken to save the colony from this reproach.

Anthornis melanura, Sparrm. (The Korimako, or Bell-bird.)

I have from time to time recorded albinoes, more or less perfect, of this species; but I have the pleasure of exhibiting this evening a specimen from Nelson in which the entire plumage is of a delicate olivaceous-yellow, the quills and tail-feathers being white with greyish webs. Bill and feet pale-brown, instead of being respectively black and leaden-grey, as in the normal state.

Referring to the Bell-bird, Lord Onslow, in the memorandum already referred to, says, "I would also, at the same time, suggest that Ministers should take into consideration the propriety of including some other native birds in the list of protected species. As I have already mentioned, the Bell-bird,

formerly so plentiful, has entirely disappeared from the North Island. But it is still very plentiful all over the South Island, and is a common denizen of the gardens and shrubberies in all the principal towns. This is the bird that so enchanted Captain Cook by its song when his ship lay at anchor in Queen Charlotte Sound more than a hundred years ago, and, having become historical, it would be a grievous pity for the bird to die out altogether. The general testimony goes to show that the protection extended to the Tuis had the desired effect, this species being now more numerous everywhere than it was fifteen years ago. Would it not be well to extend the same protection to its small congener the Makomako, whose haunts and habits are almost precisely similar?"

Xenicus longipes, Gmelin. (The Bush Wren.)

Of this bird I have obtained only four specimens since my return from Europe, although I have made constant inquiries for it. Mr. Brough writes me from Nelson, "I have now been out in the bush for six months, and have seen only one Bush Wren, two Rifle Wrens, two Saddlebacks, and no Rock Wrens. These birds are almost extinct in the Nelson and Pelorus forests, where they were so plentiful eight years ago. Weasels, ferrets, stoats, rats, and wild cats abound in our woods. Cats are the greatest enemy to the Wren family. The animals I have mentioned are making terrible devastation amongst our native birds. Wingless birds, and pigeons too, will soon be a rarity here."

Platycercus novæ-zealandiæ, Sparrm. (The Red-fronted Parrakeet.)

To the many recorded varieties of this well-known species I have now to add another in the remarkable specimen (from Nelson) which I have the pleasure of exhibiting. The plumage of the upper surface is intermixed with bright canary-yellow, this colour predominating on the wing-coverts, back, rump, and upper tail-coverts. The outer tail-coverts are varied with yellow, and there are scattered feathers of the same colour on the cheeks, throat, and fore-neck.

Another, which I had lately an opportunity of examining, differs from ordinary specimens in having the first bastard quill in the right wing yellowish-white, with a blue-black tip, and the corresponding feather in the left wing entirely yellowish-white; it likewise has the innermost secondary lemon-yellow, with touches of the same colour among the wing-coverts, and on the back and rump; whilst the primaries on the left wing are yellowish-white at their tips.

Carpophaga novæ-zealandiæ, Gmelin. (The New Zealand Pigeon.)

A partial albino received from Wanganui has the head, neck, breast, and upper surface of wings and back dull yellowish-brown, with numerous yellowish-white feathers on the back and rump, and a few widely-scattered ones among the larger wing-coverts; all the smaller wing-coverts and the interscapulary feathers rich vinous-brown, with a perceptible sheen, forming a sort of mantle; wing-feathers and tail-feathers of the same yellowish-brown colour as the body-plumage, with paler tips; bill and feet normal.

Another specimen (obtained from the woods near Levin) has the plumage entirely white, with only a tinge of cream-colour on the upper surface of wings and on the hind-neck.

In Mr. Drew's collection at Wanganui there is an absolutely pure albino, obtained in that district.

Numenius uropygialis, Gould. (The Australian Whimbrel.)

This species must be added to the New Zealand list. A specimen (now in the Colonial Museum) was shot by Mr. S. Liardet in the Wairau district, and was presented by Mr. W. T. L. Travers to the Museum. The bird agrees exactly with Gould's description of this species in "The Birds of Australia," but he curiously omits to notice that the sides of the body and undersurface of wings are conspicuously marked with arrow-head bars of blackish-brown, and that the long axillary plumes are transversely barred in their whole length with the same. This specimen measures: Extreme length, 17in.; wing, 9in.; tail, 3·5in.; bill, along the ridge (following curvature) 2·35in., along the edge of lower mandible 2·5in.; bare tibia, 1in.; tarsus, 2·25in.; middle toe and claw, 1·6in.

Gallinago aucklandica, Gray. (The Auckland Island Snipe.)

The length of the bill is evidently a very uncertain character with this species. A specimen in my collection, brought to me in spirit from the Auckland Islands, has a bill measuring 3in. from the angle of the mouth to the tip, and 2·6in. along the culmen.

Lobivanellus lobatus, Vieill. (The Australian Wattled Plover.)

In "The Birds of New Zealand" (vol. ii., p. 13) I have described a straggler of this beautiful species of Plover, obtained by Mr. Drew at Kai-iwi, near Wanganui, in August, 1886. The specimen is still in his interesting little museum at Wanganui.

The distinguishing features in this bird are the lobed mask of pale sulphur-yellow, and the sharp spur, more than half an inch in length, at the bend of the wing.

Mr. C. A. Barton, writing to me from Hokitika, describes what is certainly either *Lobivanellus lobatus* or *L. personatus*, of Australia, as occurring there. He says, "Can you inform me if there is in Australia a spur-winged wader about the size of an Oyster-catcher? Several times lately I have observed a *rara avis* in the sandbanks of the Hokitika River, that, from what I have been able to observe through a field-glass, would be classed between the Dottrels and Oyster-catchers; but I am nearly sure that it has well-developed spurs (say half an inch long) on the wings, and a flap-wattle (pale-yellow) covering the sides of the face and extending back to and close round the eyes. And the bill, I think, is soft or rather weak, and about half as long again as the head." I refer this bird to *L. lobatus*, because the one obtained at Kai-iwi was of that species.

Pelecanus conspicillatus, Temm. (The Australian Pelican.)

I have in my possession the head and neck of an Australian Pelican which was shot by the Maoris on the Wanganui River bank about a mile above Hiruharama. This was in 1890. The bird was first observed in the early morning, and, being entirely strange to them, the Maoris brought the head and neck to Wanganui (in the flesh) for identification, but unfortunately left the body, which was soon devoured by the pigs.

Of this fine species Mr. Gould writes, "It is abundant in all the rivers and inlets of the sea, both in Tasmania and on the Continent of Australia. I shot specimens on Green Island, in D'Entrecasteaux Channel, and I also met with it in abundance in South Port River. Owing to the advance of colonisation it had become scarce in the Derwent and Tamar when I visited Tasmania, but it may still breed on the small group called Stanners Bay Islands, lying off the south-western land of Flinders Island, in Bass's Strait."

Puffinus carneipes, Gould. (The Flesh-footed Shearwater.)

By the kindness of Mr. Reeves, the lighthouse-keeper on Mokohinou Island (in the Hauraki Gulf), I have obtained a pair of these birds in spirit. The species appears to have a strictly northern range, for I have never heard of a specimen further south than the Bay of Plenty, where there is a breeding colony of them, although in a very inaccessible place on the Island of Karewa.

Diomedea fuliginosa, Gmelin. (The Sooty Albatros.)

Captain Fairchild, ever on the alert for new or interesting birds, brought me a pair of these birds which he had shot from an open boat a few miles north of Cape Palliser. He states that during the many years he has been navigating on this coast he has never before met with this Albatros so far north as that.

Majaqueus æquinoctialis, Linn.

The carpenter of the "Hinemoa" has described to me a large Petrel, of which he obtained two specimens at the Auckland Islands—of blackish-grey colour, with a triangular white patch on the throat. Is not this *M. æquinoctialis ?*

Thalassæca glacialoides, Smith. (The Silvery-grey Petrel.)

I have recently obtained a fine pair of this rare Petrel—one bird coming from Nelson and the other from Otago.

Anas chlorotis, Gray. (The Brown Duck.)

This Duck is still very plentiful on the west coast of Wellington. I have lately seen a flock of two hundred or more in the Papaitonga Lake; but they have become very shy, and it is almost impossible to get near enough for a shot. During the day they generally remain concealed in the dense beds of raupo along the shores of the lake, coming out to feed in the evening. In the cool hours of the day, however, they may often be seen consorting in a large flock on the surface of the water.

A specimen which has lately come into my possession has nearly the entire head pure-white, while the rest of the plumage is normal.

It is probably to a similar form that the following letter from Captain Mair (June 30) relates: "For a whole week before the shooting-season commenced we saw a pair of beautiful Ducks or Teal with *white* heads. I went out several times after them, but could not get nearer than 60 or 70 yards. The head and neck was white, like the female Paradise Duck, only it was a purer white, and the birds were small—hardly bigger than the Black Widgeon. They were very conspicuous, and could be noticed a quarter of a mile off. We saw them nearly every day for a fortnight. But unfortunately two men came to my place [on the Manawatu River] on Good Friday and shot all over it during my absence, and I fear they must have killed or wounded these birds, for we have seen nothing of them since. When observed these birds were always in company with about a dozen Spoonbill Ducks."

Nyroca australis, Gould. (The White-eyed Duck.)

A specimen was lately obtained in the Wairarapa Lake. There are several in the Canterbury Museum, all from Lake Ellesmere.

Casarca variegata, Gmelin. (The Paradise Duck.)

This fine Duck, formerly so plentiful in the Marlborough District, is becoming scarce, large numbers perishing every season through taking the poisoned grain laid for rabbits. A Marlborough resident informs me that years ago he was a constant attendant when the Maoris hunted the "flappers," or moulting birds when incapable of flight, and that he has known upwards of five thousand to be taken in this manner during a single season. They are now counted only by tens and twenties.

Apteryx bulleri, Sharpe. (The North Island Kiwi.)

I have to notice a singular development in the bill of a Kiwi from the Hawera district which was kindly presented to me by Mr. S. H. Drew, of Wanganui. The lower mandible is bent downwards at the tip, after the familiar form of a boat-hook (see fig. 1, Pl. VI.). Most of the toes are without claws, having blunt and rounded extremities. I think this condition is due to the bird having, when very young, passed over ground on which a fire was smouldering, using the bill in the manner habitual to it, and getting severely burned in consequence. Notwithstanding these drawbacks, this Kiwi seemed to have had no difficulty in procuring food, and was in excellent condition of body when presented to me. As requested by Mr. Drew, I turned it loose on my little wooded island at Papaitonga, where it will have the companionship of its own and other species.

ART. X.—*Further Notes on the Birds of New Zealand.*

By Sir WALTER L. BULLER, D.Sc., K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 18th January, 1893.*]

THIS budget of notes, which is merely a continuation of a similar paper read at a former meeting, is probably the last I shall offer to this society for a considerable time, as I purpose leaving in a few weeks for Europe, and may be absent from the colony several years.

Almost every fact of any value or significance which has come to my knowledge since the publication of my "Birds of

New Zealand" will now have been recorded in the pages of our Transactions. It is only by a systematic record of this kind that we can ever hope to obtain a complete "history." I earnestly hope, therefore, that the numerous workers in local science whom I am leaving behind will feel it incumbent on them to register their observations from time to time, always bearing in mind that an ounce of well-ascertained fact is, as a rule, worth more than a bushel of theory. We have yet much to learn, especially in a new country like this, of the life-economy and habits of every species; and it seems to me that our Society fulfils its most important function when it places on permanent record, for the student of the future, the gatherings of the local naturalists, however unimportant they may at the time appear. An observation, trivial in itself, may hereafter, in association with other observed facts, possess a special value in the elucidation of scientific truth.

Glaucopis wilsoni, Bonap. (The Blue-wattled Crow.)

This bird is becoming very rare where formerly it abounded. During a recent expedition into the Tararua Ranges, extending over three days, I met with only one, a fine adult male, which I had no difficulty in shooting, as the bird is not shy. It made a beautiful cabinet specimen, although soon after death the rich mazarine-blue faded out of the wattles, and they became black as the skin dried. My son, Mr. Leo Buller, has the following note in an old diary: "While out pig-hunting on the ranges near Whangarei, on January 15, I found a Kokako's nest, which contained two young birds. These made their escape from the nest, but the dog caught them, killing one in the operation. I endeavoured to keep the other alive in a cage, but it moped and died."

Glaucopis cinerea, Gmelin. (The Orange-wattled Crow.)

Dr. Cahill kindly presented me with a live bird which he had received from Westport, and I had it in my possession many months. Finally it died in a fit, due, I think, to over-feeding without the stimulus of freer exercise. It was an adult male and in perfect plumage, with bright-orange wattles, dark-blue at the base. Its habitual note, emitted frequently, but chiefly in the early morning and forenoon, was a long, plaintive double-note, pitched in a minor key, very pleasant to hear, but to my mind possessing less richness than the organ-note of the North Island bird (*G. wilsoni*). It was accustomed to use its feet on eating leaves or berries presented to it, just as a Parrot would. On offering this bird a large blue-bottle fly he held it to his perch in the manner described, and deliberately tore off one wing, then the other, tasted its flavour, and immediately dropped it. As a rule he would not touch in-

sects, but showed great fondness for succulent leaves of any kind, particularly those of *Coprosma lucida*, and all sorts of native berries, whether ripe or green. He ate freely of the ripe fruit of the whauhe, but it had a scouring effect, and I had to discontinue the use of this food. It partook readily of cooked potato, boiled rice, and soaked bread; and it was fond of water, drinking freely, but rarely washing itself as other birds do, and yet its plumage was always in clean, silky condition. The wattles were always carried tightly compressed under the chin and meeting at their edges. As I became better acquainted with the bird I found that it possessed several notes besides those described in the recorded history of the species. In the early morning, or before rain, it had a melancholy call like "*Kowai-koe ?*" in a high key; at other times a mellifluous whistle, and every now and then a note quite indistinguishable from the short bell-toll of the Tui. To this is no doubt due the circumstance that this is the Bell-bird of many of the country settlers. Occasionally, but not often, he sounded the rich organ-note—short, but of surpassing sweetness—and at other times a soft note in repetition like the low whimper of the Huia. The mention of yet another note, not unlike a short, hollow cough, will prove that this bird was not wanting in vocal accomplishments. Curiously enough, after losing its tail by accident, the Kokako moped and hardly uttered a sound, as if ashamed of the sorry condition it presented; and as the new tail began to show itself the bird regained its wonted sprightfulness.

Heteralocha acutirostris, Gould. (The Huia.)

To show how much scarcer this bird is than it was formerly, I may mention that a few months ago, accompanied by Mr. Morgan Carkeek, I made an expedition into the wooded ranges at the back of Waikanae. We crossed the Akatarewa saddle into the valley of the Hutt, and made a ten-mile circuit over the wooded ranges, cutting our path with bill-hooks through the virgin forest, rendered almost impervious by a tangle of kiekie and supplejack, and camped several nights in the woods. During the whole expedition we only saw a single Huia—a male bird, which visited our camp in the early morning. Mr. Carkeek assures me that when exploring and surveying in these ranges only five or six years ago the Huia was comparatively plentiful.

On a more recent occasion, accompanied by a Maori, I visited the portion of the Forty-mile Bush where, as related in my "Birds of New Zealand," I obtained so many specimens in 1883. But the bush has completely disappeared before the advancing wave of European settlement. From Pahiatua we rode for twenty miles through clearings exhibiting nothing

but charred and naked stumps, the whole of this country being at the time of my former visit covered with beautiful forest. From the practical standpoint of material advancement there is nothing regrettable in this; but the fact remains that the home of the Huia is being swept away, and, although these birds, in greatly-diminished numbers, have taken refuge in the wooded mountain-ranges, the date of their extinction cannot be very far distant.

In conversation with intelligent men in the survey parties, I obtained some interesting particulars relating to the Huia in its native haunts.

As illustrating its extreme docility, even in a wild state, Petersen, a very intelligent man in the survey party, who was specially recommended to me by Mr. Climie because of his knowledge of the Huia and its habits, related the following incidents.

On one occasion, almost immediately after pitching a temporary camp in the ranges, Petersen found that a pair of Huias had a nest in the vicinity—in fact, not ten yards from the camp. On an old gnarled rata a branch overhung another part of the tree in such a way as to present a broad covered ledge, and this was the spot the birds had selected for their nest. There were three young ones; this being the only instance, Petersen says, of his finding so many, the usual number being two. The Huias were very tame and fearless, the female bird allowing herself to be handled on the nest. In the evening Petersen took her off, and, placing her on the ground near the camp fire, gave her some food, which was very readily taken. The bird was then replaced on the nest, and manifested no concern at this familiarity. In a few days' time the survey party had to shift camp, and, to their credit, the Huia with her callow young remained unmolested. On another occasion he found a Huia's nest containing a single nestling: this was low down in a wooded valley near a stream of water, whereas all others seen by him were near the summit of the range. The nest was not in a hollow tree, but in the depression formed at the top of a truncated one, with a mass of overhanging vines and epiphytic growth, affording it complete shelter. He took the nestling and placed it in a cage made of kareao-vine, which was then suspended from the ridgepole inside the men's tent. The old birds followed him to the camp, and continued to feed their young one, coming into the tent for that purpose quite regardless of the men's presence. The nestling got strong and robust, but was so noisy in the early morning that the men complained of its disturbing their rest, so the owner passed it on to a settler in the Makuri Valley. He kept it for a considerable time, but one frosty night its cage was left exposed, and in the morning the

Huia was dead. Shortly after this, one of the survey hands brought him two young Huias, taken from one nest. The old birds remained in the vicinity; and, after facetiously "making a new species," by snipping off the white tips of the tail-feathers with a pair of scissors, he turned the young birds adrift, whereupon they joined their anxious parents and disappeared in the woods.

The nesting-season of this species must be well over at the end of November, for all the female birds I obtained at that date, although greatly denuded of feathers on their underparts by their protracted labours in the way of incubation, were recovering their yellow fat in various parts of the body. I think the male bird must assist more or less in the work of incubation, for most of those I killed at that period had the underparts bare, but to nothing like the extent presented by the other sex. In the stomachs of eight which I opened at this season I found very few insect remains, but abundance of vegetable matter, among which I was able to distinguish a ripe berry of porokaiwiria and the pulp of others, with numerous seeds of tawhero and kaikomako. In the stomach of one I found a spider, and the remains of a small weta or tree-cricket.

I am informed by Mr. Drew, of Wanganui, that he lately had a beautiful albino Huia offered to him in the flesh, but unfortunately allowed it to pass him. I have since endeavoured to trace this specimen, but without success.

Creadion carunculatus, Gray. (The Saddle-back.)

I recently received a fresh specimen from Stephen's Island (in Cook Strait) which possesses special interest, not only as proving that the species still exists in this part of the colony, but because it is a very young bird (in the true plumage of *C. carunculatus*), with very small caruncles and a narrow yellow membrane at the angles of the mouth. The only difference in the plumage is that it is duller than in the adult. Such a specimen as this establishes beyond all doubt the validity of *Creadion cinereus* as a distinct species.

Creadion carunculatus is still to be met with on several of the wooded islands in the Hauraki Gulf, but it has entirely disappeared from the mainland. I expected to find it on the Island of Kapiti, but the natives assured me that it had not been seen there for many years.

Turnagra crassirostris, Gmelin. (The South Island Thrush.)

Of this species I have also lately received a specimen from Stephen's Island; so it is to be hoped that these small island sanctuaries will be the means of preserving many of these rare forms.

A caged specimen recently brought to me by Mr. Capper presents the abnormal feature of the whole of the middle portion of the tail being yellow, with a brown streak down the shaft of each feather.

Turnagra hectori, Buller. (The North Island Thrush.)

Through the courtesy of Mr. J. D. Climie, District Surveyor, I recently received from the Makuri Ranges a fine specimen of this rare species, positively the first I have seen in the flesh for twenty years and more.

It is to be hoped that when the Little Barrier Island has been acquired by the Government for the purposes of a "native birds' sanctuary" at least one pair of the North Island Thrush (which is easily caught when found) may be obtained, and liberated there, so as to save the species from ultimate extinction. I have heard from surveyors and others that it is occasionally met with (always in pairs) along the Hunterville line of road, and in the wooded district north of Wanganui.

Prosthemadera novæ-zealandiæ, Gmelin. (The Tui.)

From Hastings, under date of the 18th January, the Hon. Captain Russell sends me the following note: "I have one good large plant of the mountain-flax growing in my garden here. It was planted by myself many years ago. This evening *one* Tui was hopping about it extracting the honey. Almost every season a *pair* of Tuis appear, when the flax-plant is in bloom, remain a day, and then vanish—where? Why do they come? And whence? There is abundance of the swamp-flax not far away, but I have never observed a Tui upon it. There is no native bush, as you know, within miles of Hastings. Possibly you may not think the circumstance strange, and I mention it only because it seems so to me." In reply I have told Captain Russell that the instance he records is by no means uncommon, but that it is quite impossible to account for these vagaries on the part of wild birds. There is a very remarkable case within my knowledge of a Wood-pigeon (*Carpophaga novæ-zealandiæ*) which, for years past, has at a particular season visited a flowering yellow kowhai in a garden in front of Tinakori Road, in the suburbs of Wellington—miles away from the nearest haunt of the Pigeon—remains a day, and then disappears. It may, I think, be safely assumed that the same individual bird comes back season after season; and, whatever else it may indicate, it seems to furnish good evidence of the existence of memory in birds as a permanent faculty. The same thing has been observed of the common Seagull (*Larus dominicanus*). Birds that have been reared by hand in the poultry-yard and have subsequently gone wild will, years after, revisit the scenes of

their youth, regale themselves for a day with the fowls, and then betake themselves to the sea again.

Anthornis melanura, Sparrm. (The Bell-bird.)

On the 15th of February last I shot a young korimako on the summit of one of the lower ranges of the Tararua, at an elevation above the sea of 800ft., about six miles in a direct line from Kapiti. I heard the sweet song of the adult, but did not actually see the bird. They were feeding on the flowers of the tawhiwhi or climbing rata (*Metrosideros scandens*), and, according to our Maori attendants, were visitors from the island, where this songster is still comparatively abundant.

Mr. Percy Smith, the Surveyor-General, has sent me the following interesting note :—

"In Dr. Lesson's 'Voyage aux Îles Mangarewa' I have come across the following : In a list of eighteen birds, of which he gives the native names, he ends by saying, '*enfin le* komako, *une espèce de* Philedon *qui ne quitte pas les lieux boisés.*' The resemblance of the name to our komako or korimako, together with its scientific name being identical, would seem to prove that the Gambier Islands have a representative of our bird there. You have not noted the fact in your 'History,' so the information is probably new to you, and is of much interest.

"As Dumont d'Urville and Beechey both visited Mangarewa in the earlier years of this century, possibly one or both of them have notices of the bird. What a mistake it is that D'Urville's great work cannot be seen in this country !"

Xenicus longipes, Gmelin. (The Bush Wren.)

For the first time in the North Island, I saw this bird (at any rate I feel persuaded it was) on the 29th November, but only on the wing, in the wooded hills just beyond the Makuri Gorge. It crossed the road at a moderate height with a very laboured flight, and was immediately lost among the foliage.

The natives state that formerly the Bush Wren (the Matuhituhi) was numerous here and at a higher elevation on these wooded ranges.

Acanthidositta chloris, Sparrm. (The Rifleman.)

This appears to be a late breeder. On the 28th November, in the Puketoi Range, I was sitting on a log skinning a Huia, and the camp was perfectly still. On the ground around were numerous feathers of a Kaka my Maori attendant had plucked for breakfast. A Rifleman (the male bird) came almost to my feet, and, picking up a feather, flew away with it, and then a second and a third. On the last occasion I followed the bird, and saw it enter a round cavity about the size of a rat's hole, sixteen or eighteen feet up the trunk of a young hinau. The

day following, in the Makuri Gorge, I saw another of these birds carrying a feather, evidently for nest-building purposes.

Eurystomus pacificus, Latham. (The Australian Dollar-bird.)

I have already recorded several occurrences of this vagrant species in New Zealand, chiefly on the west coast of the South Island. The following paragraph recently appeared in the *New Zealand Herald* (Auckland):—

"Some specimens of the Australian Dollar-bird have appeared in the Wairoa district, and some of them have been shot out of curiosity. They are entirely insectivorous, as can be seen by a careful observer, and as was proved by a *post-mortem* examination of one."

This was in the month of November. It is to be hoped that the species will become a permanent resident with us. Another useful Australian bird, *Gymnorhina tibicen*, introduced by the settlers, is becoming well established in various parts of the country.

Stringops habroptilus, Gray. (The Kakapo.)

Captain Mair writes me that, according to the Maoris, on Hauhangataho, an isolated hill about ten miles to the westward of Ruapehu and the watershed of the Manganuiateao, Kakapos are still plentiful. His informant, Wi Takerei, showed him the feathers of two he had killed at the foot of the Kaimanawa Range, near Tokano.

The food of the Kakapo consists entirely of vegetable matter, and it has a prodigious appetite. In a standard American work appears the extraordinary statement that it "burrows in the ground or in holes in the rocks, and feeds upon worms and grubs"!

I have never met with an albino Kakapo, but several of my specimens show a strong tendency to yellow, some of them having the plumage of the underparts entirely suffused with that colour.

Platycercus unicolor, Gray. (The Antipodes Island Parrakeet.)

Several more specimens of this interesting Parrakeet have been brought by the "Hinemoa" from Antipodes Island. Although captured as adult birds they take readily to confinement, and do not fret, as most other birds do, at being caged. I have noticed that this species has a habit of resting at night in an upright position, holding on to the wires of its cage by both bill and feet.

Spiloglaux novæ-zealandiæ, Gmelin. (The New Zealand Owl.)

The Morepork is so strictly nocturnal in its habits that I ought to make special mention of one which has taken up its abode in a small clump of bush near my homestead on the Papaitonga Lake. This bird may be heard calling at all hours of the day, even in the broad daylight, and is frequently visible as he moves noiselessly from tree to tree. In this little bush reserve I am endeavouring to cultivate the native flora from all parts of the Island, and the Maoris facetiously say that this particular owl has stationed himself there to keep guard over "Maui's Garden." This diurnal character is quite exceptional; although even in my own garden on Wellington Terrace I have known a Morepork on a dull afternoon, but in broad daylight, truss a sparrow in its talons and bear it off, causing consternation to the whole community of sparrows far and wide, who undoubtedly have the power of conveying information to one another, and assemble accordingly in a sort of noisy indignation meeting.

I found this little Owl very numerous in the *Fagus* forests of the interior, its nervous call always commencing as soon as the gloom of evening covers the silent woods. During wet nights it appears to feed on the large brown beetle (*Prionoplus reticularis*), which flies in the rain.

Sceloglaux albifacies, Gray. (The Laughing Owl.)

This fine Owl is now on the verge of extinction; indeed, I have made such persistent efforts all over the country to obtain specimens, since my return from Europe about three years ago, that I think it highly probable the single live pair which I have been fortunate enough to procure will be the last we shall ever get. These have been sent to England, and will be kept in an aviary specially prepared for them. Seeing that the single bird belonging to the Canterbury Acclimatisation Society lived in confinement some eighteen years, and laid an unfertilised egg (now in the Canterbury Museum) shortly before its death, we may reasonably hope that my captive birds will breed in their new home, and that in this way the race will be perpetuated.

Mr. W. W. Smith, of Ashburton, who has been indefatigable in his efforts to obtain specimens for me, writes from Oamaru, "The species inhabited this district plentifully forty years ago, but has now entirely disappeared. I have gathered the castings for miles around, buried in the sand or dust covering the bottom of fissures in the rocks." He attributes the final extirpation of this fine bird to the introduction by the Government of the weasel for the suppression of the rabbit nuisance.

My two live Owls were remarkably docile and gentle, allowing themselves to be handled freely without any attempt to bite or use their claws. When shipped to England they were in very handsome condition. The female (always the finer bird among this class) had the face almost perfectly white, the feathers composing the disc having black hair-like shafts and filaments, and those along the outer edges, composing the fringe, having black centres; wing-coverts presenting numerous large rounded spots of yellowish-white, their markings increasing in size and becoming lozenge-shaped on the scapulars, there being one on each vane, that on the outer vane being very white and conspicuous; transverse bars on upper surface of tail broad but obscurely marked. Bill bluish-grey, yellowish towards the tip and along the cutting-edge; cere pale greenish-yellow; irides dark lustrous-brown, almost black; toes pale-yellow, the claws grey, with darker points.

The other bird (which I assume to be a male) is scarcely inferior in size, but has the plumage generally duller, the white markings less conspicuous, with the bill and feet paler-coloured.

The latter, on being taken from its cage to be photographed by Mr. Henry Wright, manifested so persistent a desire to get away from the light, and to hide itself in the shade of the ferns among which I had placed it, that it was very difficult to obtain a momentary shot in focus, although in the end the result was a highly satisfactory one. During the day it had a listless, dazed look, and generally kept its eyes partly closed. The only occasion on which I saw it awake from this lethargy was when I brought a live Hawk (*Circus gouldi*) near to the wire-netting of its enclosure. It did not then manifest any excitement or alarm, but slowly raised itself up to its full height two or three times in succession, with the feathers of the head puffed out and the eyes opened to their full extent, in silent wonderment at so strange an apparition.

Both birds exhibited the same natural docility. On being taken hold of by the feet they would offer no resistance and utter no sound, but would simply flap their wings slowly, and turn their dark orbs full into the face of their captor, as much as to say, "And, pray, what may this mean?" They ate very sparingly of their food (lean mutton or sliced ox-heart), and always at night. During the time they were in my possession I never heard them emit any sound.

Mr. Morgan Carkeek, on seeing mine, assured me that he had seen one of these Owls before. It was some years ago, when he was surveying for the Government in the neighbourhood of Porirua Harbour. On entering an abandoned Maori hut in the day-time he found one "roosting" there. It was very tame, and remained there several days. He brought it

food from time to time, and it made no attempt to escape from the hut. To the Maoris of his survey party it was quite a new bird.

Mr. Jacobs, the taxidermist at Masterton, has given me a characteristic account of a very fine one which he obtained alive at Nelson, and afterwards mounted for the local Museum. A man, so he informed me, was travelling from Nelson to the West Coast, when he observed a large Owl squatting on the ground near the roadside. He dismounted from his horse and caught the bird. Then, selecting a retired nook in the adjoining woods, he drove a thick pole into the ground and secured his captive to it by the leg, allowing a sufficient length of flax to permit of the Owl moving freely about over the ground. On his return by the same road two days later he found that the bird had snapped, or in some way had got disengaged from, the flax string, and was perched on the top of the pole, permitting itself to be recaptured without the slightest resistance. He took it on with him to Nelson, and, not knowing its value, sold it to the narrator for a few shillings. It now graces the collection in the Nelson Museum.

Harpa novæ-zealandiæ, Gmelin. (The Sparrow-hawk.)

This is becoming one of the rarest species, which is difficult to account for, seeing that the zeal of our acclimatisation societies has added so much to its bill of fare by the introduction of sparrows and numerous other small birds. As an illustration of this, I may mention that on a recent occasion I was riding with a Maori youth from Ohau to Manakau when a Sparrow-hawk flew across the road. My companion asked what it was, never having seen one before, although he had lived in the district all his life.

Himantopus novæ-zealandiæ, Gould. (The Black Stilt.)

The following is a description of an almost entire albino which I lately had the opportunity of examining: The whole of the plumage is white, stained more or less with ash-grey, especially on the upper parts, being darkest on the crown and sides of the head; among the wing-coverts and in the region of the back a few widely-scattered black feathers; quills and tail-feathers white freckled with grey; inner lining of wings dark ash-grey as on the crown. Bill and feet normal.

Gygis alba, Sparrm. (The White Tern.)

I have received a beautiful specimen of this snow-white bird from the Kermadec Islands, from which locality Mr. T. F. Cheeseman has already added it to our list of species.

Sterna nereis, Gould. (The Little White Tern.)

It is not often that this species leaves the sea-coast; but on a recent occasion I observed a pair of them fishing in fresh water on the Papaitonga Lake, several miles from the sea. They were dipping into the water, with a tiny splash, at rapid intervals, and, as there can be no whitebait at this season (December), I much fear that they were regaling themselves on the fry of Loch Leven trout, of which I lately placed six thousand in the lake.

Ocydromus australis, Sparrm. (The South Island Woodhen.)

In spite of its feebleness of wing, this species continues to hold its own in many districts of the South Island. It is very prolific, and breeds freely in confinement. Mr. W. W. Smith, of Ashburton, sent me a fine series of eggs which had been laid by birds in captivity. In the letter accompanying them he says, "I have one pair of these birds that has reared two broods, and has a third three weeks old. I took the young away much earlier than the parents would have left them, which made them lay much sooner. I have another bird which has laid sixteen eggs. My efforts to procure a hybrid between the Game-cock and Weka have not so far been successful, but I shall persevere with my experiments, and may ultimately succeed."

I learn from Sir George Grey that those which he brought from the South Island and turned loose on Kawau in 1863 increased rapidly, and soon stocked that island.

Ocydromus greyi, Buller. (The North Island Woodhen.)

I received on the 6th January from Captain Mair two newly-hatched chicks of this species, obtained on the banks of the Manawatu River. They were thickly covered with silky down of a uniform brownish-black colour.

Ocydromus earli, Gray. (The Brown Woodhen.)

I have received a fine series of specimens from the valley of the Heaphy, where this Woodhen appears to be the common species. As stated in my account of the species ("Birds of New Zealand," vol. i., p. 115), Reischek met with it on Mount Alexander and afterwards on Cooper's Island, as well as on the mainland opposite, so that the range of the bird appears to extend all the way down the coast.

Ocydromus fuscus, Dubus. (The Black Woodhen.)

I have lately obtained a living pair from the West Coast sounds. Like the other species, they are almost omnivorous, and large feeders, and I have noticed that they have a great

partiality for the common garden snail, breaking the shell by a prod of their powerful bills and tearing out the contents after the manner of a true expert. Doubtless the common Woodhen would do the same, in which case it would be a most valuable introduction into gardens infested with snails, as most of those in Wellington are.

The Black Woodhen has all the habits of the more common species, so fully described elsewhere, but it has a peculiar note, frequently emitted, and responsively, when the birds are together, so much like the clucking of domestic hens that it is difficult to believe one is not in the vicinity of a poultry-yard.

Ardea maculata, Latham. (The Little Bittern.)

I am indebted to Mr. C. A. Barton, of Hokitika, for a specimen of this Bittern, which continues to be one of our rarest species. All the hitherto-recorded examples have come from the South Island.

Ardea egretta, Gmelin. (The White Heron.)

Through the exertions of Mr. St. Clair Liardet, who informs me that he was more than a week in pursuit of the birds before he could get a shot, owing to their extreme shyness, I have received from Collingwood a magnificent pair of the White Heron, or "White Crane," as the colonists prefer to call it. The plumage is of snowy whiteness throughout, and both sexes are furnished with the filamentous dorsal train, which is, however, richer in the male bird.

Almost without exception, New-Zealand-killed examples at all seasons of the year have the bill entirely yellow; but a specimen shot at Lake Te Anau in December last (and now in Mr. Melland's possession) exhibits the entirely-black bill which is a regular seasonal character with this species in India. This particular bird was in beautiful plumage, with ample dorsal mantle of filamentous feathers, being apparently a male.

Botaurus pœciloptilus, Wagl. (The New Zealand Bittern.)

The young differs from the adult in its smaller size and much paler plumage; the blackish-brown on the front and sides of the neck is entirely absent, there being in place thereof a broad central irregular stripe of cinnamon-brown; and the soft spreading plumage is of a pale-tawny colour, with numerous transverse V-shaped markings of pale cinnamon-brown; the brown lanceolate markings on the breast and sides of the body are paler than in the adult, and the plumage of the upper surface of the body is altogether lighter and more largely suffused with tawny-yellow or buff.

This species, formerly so abundant on the west coast of this province, is getting scarce, owing to the draining of the swamps as the inevitable result of systematic settlement.

Phalacrocorax nycthemerus, Cab. (The Campbell Island Shag.)

The two sexes are crested, and both appear to have exactly the same plumage in the adult state. My specimens are from Campbell Island, and I have never heard of the occurrence of the species elsewhere.

Diomedea regia, Buller. (The Royal Albatros.)

I have compared male and female specimens obtained on the east coast of Otago, and I can detect no difference whatever between the sexes, except that the male has a somewhat thicker bill. The female may have a little more white on the upper surface of wings, but this character is a variable one.

Diomedea exulans, Linn. (The Wandering Albatros.)

Specimen received in the flesh from Captain Fairchild, who took it himself off the nest with a nestling beside it. This is a parti-coloured bird, in what I take to be the intermediate or transitional plumage, perhaps that of the second or third year, or even later. Upper surface blackish-brown, darker on the wings and tail; band across the forehead, immediately above the bill, with the whole of the face and throat pure-white; neck and fore-part of breast sooty-brown, paler on the anterior edge, broken and freckled on the lower margins; lower part of breast and abdomen pure-white, largely freckled on the sides of the body with brown; flanks, vent, and under tail-coverts sooty-brown; wing-feathers black with white shafts; lining of wings pure-white, varied with black on the outer edge; tail-feathers black, the shafts white at the base. No white markings on the upper surface of the wings.

It is notoriously difficult to rear the young of the Albatros; indeed, it is generally considered an impossibility. But at Government House there is now a fine bird, in perfect first year's plumage, which was brought there as a down-covered nestling four months ago. It has the freedom of a small enclosure, and is fed almost exclusively on fish.

Diomedea cauta, Gould. (The Shy Albatros.)

The first mate of the "Hinemoa," Mr. Bethune (who showed me the heads of all the species), assured me that *Diomedea cauta,* which is appreciably larger than *D. culminata,* is found only on the Bounty Islands. Both these species are furnished with the peculiar moustachial membranes already

described, which they disclose by raising the feathers when irritated or excited. Captain Fairchild says, "All the Albatroses on Antipodes Island are dark birds" (*D. exulans*). *Diomedea regia* is never found there; and, so far as I can learn, *D. regia* is the only species that inhabits Campbell Island.

Phœbetria fuliginosa, Gmelin. (The Sooty Albatros.)

The egg of this species, as described in "The Birds of New Zealand" (vol. ii., p. 206), is more or less spotted, especially towards the larger pole; but one of the officers on board the "Hinemoa" has a specimen in his possession which is perfectly white; and I find that Dr. Kidder, in his description of the birds of Kerguelen's Island, says of this species, "The egg is single, white, and very long in proportion to its thickness." On its nesting habits he gives the following interesting particulars: "October 24: Two of the Dusky Albatroses had made a nest upon a shelf formed by a considerable tuft of cabbage and *Azorella* at the entrance of a small cavity in the perpendicular face of a lofty rock, near the top of a hill some two miles away. Here the birds could be both seen and heard. Their scream is very loud, and not unlike one of the calls of a cat. At a distance it has often been mistaken for the hail of a man. The name 'Pee-arr' has been given as descriptive of this call, which is, I believe, peculiar to the breeding-season. Another pair was seen same day circling around the same hilltop. No eggs.—November 2: Secured one egg and both birds. The nest is a conical mound, 7in. or 8in. high, hollowed into a cup at the top, and lined rudely with grass. The male was sitting when captured; the female standing on another old nest not far away, but higher up the face of the rock. There was no evidence of an intention to rebuild the old nest. Both birds, but particularly the male, showed fight when approached, clattering their large bills with an odd noise, and biting viciously when they got a chance. The male is perceptibly the larger bird of the two. Although I have often observed the Dusky Albatros sailing along very close to the surface of the water, or circling round rocky hilltops, I have never seen it feed, except in captivity. Then both birds ate freely of fresh meat. The peculiar call, which can be heard for a very long distance, is most often given by the sitting bird, and answered by its mate flying near by. . . .—November 12: I found another bird on a nest in a locality similar to that already described. It stared stupidly at me, clattering its beak, and turning its head from side to side, but making no effort to escape. There was no egg. The narrow line of white feathers above and behind the eyes gives these birds a singular and striking appearance—a

sort of wide-eyed, amazed air that distinguishes them markedly from other birds. The white feathers are very minute, but quite perfect. This last-mentioned nest was shortly after abandoned by the bird, apparently because it had been disturbed. Another bird was found sitting on an egg on November 22, high in the rocks, and some four miles inland."

Captain Fairchild brought me, in July, a pair in the flesh, which he had shot off Cape Palliser—the first time, as he informs me, he has met with the species so far north. The broad white mark which encircles the eyes, except in front, is particularly conspicuous in the male bird; and the white shafts in the feathers of the tail, which is rather long and acuminate, are a very pronounced feature. Bill ivory-black, with a pale-blue line near the cutting-edge of the lower mandible, running off to a point in front of the terminal expansion; feet pinkish flesh-white, clouded with grey at the joints, on the interdigital webs, and along the outer edge of the foot; claws white-horn colour; irides rich dark-brown. Length, 36in.; extent of wings, 82·5in.

Œstrelata cookii, Gray. (Cook's Petrel.)

I find that the size of this species is variable, a specimen sent to me by Mr. Reeves, of Mokohinou Island, measuring in the wing, from flexure to the tip, only 8·2in. Bill ebony-black; legs and feet yellowish-grey, shading into greyish-black on the outer toe; webs darker.

Œstrelata lessoni, Garnot. (The White-headed Petrel.)

Of this rare species—two examples of which, from the Auckland Islands, were exhibited by me at a former meeting of this Society—Dr. Kidder obtained only one specimen on Kerguelen's Island. On December 29 it was brought home alive by one of the men, having been dug out of a very deep burrow by the dog, at a considerable distance inland, and well up among the hills. He describes the tarsus and foot as flesh-pink, black along upper surfaces of digits and on the web near the claw, and the irides as very dark brown. He states that he saw them following the ship on the 18th January, about seven hundred miles north of Kerguelen, but unfortunately gives us no further particulars.

Halobæna cærulea, Gmelin. (The Blue Petrel.)

This species of Petrel, although plentiful in certain localities elsewhere, is very rarely found on the New Zealand coast. Dr. Kidder writes that, "upon first landing on Kerguelen's Island (September 13), the hillsides, apparently quite deserted during the day, became at night perfectly alive with these birds and a species of *Pelecanoides* (*P. urinatrix*, Gm.), flying

irregularly about the rocks and the hummocks of *Azorella*, and filling the air with their call. The note much resembles the cooing of pigeons, consisting of three short notes repeated in rapid succession and followed by two long ones, thus: 'Kŭk-kŭk-kŭk-cōō-cōō.' They seemed rarely to fly over the water, but to confine themselves to the neighbourhood of their burrows, sometimes alighting and again taking wing, very much as if there were legions of bats inhabiting the hill. I never succeeded in satisfying myself as to the object of this constant flight during the night, although I spent much time in watching them, since, so far as my observation extended, there were no night-flying insects whatever upon the island, nor did the structure of the stomachs of these birds seem fitted to an insect diet. The burrows are excavated beneath the mounds of an umbelliferous plant which abounds on the Kerguelen hillside (*Azorella selago*, Hook.), growing in dense masses of often several feet in diameter. The holes usually run straight inward for a foot or more, then turn sharply to the right or left, parallel with the hillside, thence downward, often doubling once or twice upon themselves, and communicating with other entrances. At the bottom is an enlarged cavity, lined with pine-root fibres, twigs, ferns, or leaves of the 'Kerguelen tea' (*Acæna affinis*, Hook.), and quite dry. Here the single egg is to be found, always quite covered with dry powdered earth or the leaves above mentioned. The diameter of the burrows at their entrance is about that of a man's wrist. Upon our first arrival two birds, male and female, were usually found in each burrow during the day. After they began to fly, however, but a single one was to be found with the egg, usually, but not always, the female. When set free in the day-time, the mode of flight was irregular, as if the light were confusing to the bird. They always alighted in the water, after flying a mile or so. The noise of their calling was incessant during the night, coming quite as often from the burrows as from the air, but became much less frequent after the middle of November, from which I infer that the call is connected with the season of pairing. The egg is white, single, and measures 1·9–2in. by 1·45–1·55in. The first egg was found the 23rd October, although doubtless they begin to lay earlier. A young bird covered with slate-coloured down was found the 12th November, and frequently thereafter. The traveller who should visit Kerguelen's Island only during the day, returning to his ship every night, might easily fail to observe the presence of these birds at all, since, in the neighbourhood of their burrows, they are exclusively nocturnal in their habits, being perhaps the very latest to appear after nightfall. They are, however, often seen at sea during the day, many hundreds of miles from land."

Thalassœca glacialoides, Smith. (The Silvery-grey Petrel.)

Mr. F. Sandager writes to me of this rare species (under date of 1st October), "To-day, as I was going along the beach at Moeraki, a species of *Procellarius* came in. By means of your 'Manual' I had no difficulty in identifying it as *P. glacialoides.*"

Puffinus assimilis, Gould. (The Allied Shearwater.)

Specimen in the flesh received from the Hauraki Gulf has greenish-grey feet, with yellow interdigital webs, marked with black on the outer edge; bill bluish-black.

Puffinus gavia, Forst. (Forster's Shearwater.)

Of this apparently rare Petrel I have received several fresh specimens from Mokohinou Island. Bill blackish-brown, changing to grey on lower mandible; legs and feet yellow, changing to blackish-brown on outer side of tarsus and along edge of outer toe; claws and interdigital webs black.

Majaqueus æquinoctialis, Linn. (The 'Stinker' of Whalers.)

In a former note I mentioned that the officers of the "Hinemoa" had described to me a large Petrel as existing on the Auckland Islands, which is undoubtedly this bird. Dr. Kidder, in the paper already referred to, gives some interesting particulars respecting it. He says, "A single specimen was dug up by the dog on the 12th October, from a very deep burrow under a clump of *Azorella*, but none others were seen until the 15th November, when they suddenly appeared in considerable numbers. On the 16th December I dug up specimens with eggs, and frequently thereafter. They nest in very deep burrows, with almost always a little pool of water at their entrance, and keep up an incessant squealing while the dog is digging for them, very like the sound of the water-whistle toys, or 'whistling coffee-pots,' sold on the street-corners. The note is, in other words, very shrill, and constantly trilling. They fight the dog more bravely than any other Petrels, generally coming out of the burrow hanging to his ear, and keeping him off very successfully on the open ground. The name 'Stinker' is fully warranted by the rank odour emitted by the bird, and is given on the authority of the whalers on the schooner 'Emma Jane.' Captain Fuller, however, of the schooner 'Roswell King,' a very careful observer, tells me that the Stinker is a much larger bird, and that it nests on the ridges of the high hills, not in burrows, and very late in the season. If so, I have never seen it. The egg is single and white. One of the first birds dug up by the dogs after our arrival, on the 15th September, was a large Petrel, covered

everywhere by long, grey, hairy down, and found quite near the station. They were found often afterward, and were much hunted by the dogs as food. From their squealing when captured, the structure of their bills, the depth of the burrows in which they were found, the black plumage of those subsequently taken, and their offensive odour, I supposed them to be the young of *Majaqueus*, but was assured by the whalers that they were 'Mutton-birds,' and of quite a different species. A curious circumstance with regard to them is the fact that I never succeeded in getting any positive clue to the old birds to which they belonged. At different times I set snares in front of the burrows, and sprinkled light dry earth within their entrance, but never captured any birds; nor did I find any tracks upon the earth. It certainly seemed as if the old birds had finally abandoned them. It must be remembered, also, that one of these young birds was found as early as the 15th September, and that I found *Majaqueus with eggs* on the 16th December. The Mutton-birds had certainly not begun to fly before December. Two specimens captured on the 10th November had the body still partially covered with down. The egg is single, regularly ovoid, and white, without shell-markings of any kind. It is generally, however, much soiled by secretions from the oviduct and dirt from the burrows. The shell is thin, homogeneous, and compact in structure, very smooth to the touch, but under the lens is seen to be marked by small pits and shallow linear depressions. The largest obtained measures 3·26in. by 2·17in."

Pelagodroma marina, Latham. (The White-faced Petrel.)

I am indebted to Mr. C. H. Robson for a note stating that he has obtained an egg of this species, and that, instead of being all white, the larger end is sprinkled with reddish-brown spots. He is possibly mistaken in the bird, for I have recently obtained a number of specimens from Otago, together with the skins of the birds, taken from the burrows, and in all cases the shell is entirely white. The egg of *Garrodia nereis* (the Grey-backed Storm-Petrel) is, however, marked in the manner described. He may therefore have confounded the two species.

Oceanites oceanicus, Kuhl. (Wilson's Storm-Petrel.)

Referring to the specimens obtained by Dr. Kidder's expedition on Kerguelen's Land, Dr. Elliott Coues remarks: "I have looked at a great many 'Wilson's Petrels' from various parts of the world without having been able to see any differences between them. In any event, the bird here presented is the original *oceanica* of Banks, Kuhl, &c.; it is the other one, *wilsoni*, Bp., 1824, which is to be cut

away from this one, if any division is attempted. Bonaparte has the thing hind part before in his 'Conspectus.'" Of the habits of this species on shore the following interesting particulars are given: "These birds are crepuscular near the shore, like *Garrodia nereis*, and much more common near our station after their first appearance on the 8th December. I had previously seen them at sea east of the Cape of Good Hope; and on the 14th December I saw them clearly out by day, feeding on the oily matters floating away from the carcase of a sea-elephant. They frequent rocky parts of the hillsides, and flit about very like swallows in pursuit of insects. There seemed to be no flying insects on the island, however, other than very minute gnats. The two specimens preserved were shot on the evening of the 29th December, among the rocks near the top of the hill on which we were encamped. I never succeeded in finding the eggs, but learn from the Rev. Mr. Eaton, who found one on Thumb Mountain, some fifteen miles from our station, that it is single, white, and that the nest was made under a large rock not far from the beach. He found the egg on the 8th December. I have no doubt from what I have observed of its habits that it nests among and under rocks habitually, and usually at a considerable elevation above the sea."

Hymenolæmus malacorhynchus, Gmelin. (The Blue Duck.)

The male bird has a fine metallic-green gloss on the head, neck, and upper surface generally, being brightest on the crown and on the mantle. The female has less gloss, having a wash of bronzy-brown on these parts, this colour being most pronounced on the crown of the head and mantle. A young male (of the first year) has the same brown tinge on the upper surface, but less than in the adult female. In the mature bird the bill, with the exception of the dark terminal membrane, is in life of a beautiful pinky-white colour; in the young bird it is of a bluish-white, with a narrow streak of brown down the centre. Both sexes have the soft feathers which compose the inner lining of the wings more or less tipped with rufous; the male has the under tail-coverts broadly tipped with rufous-red, whilst in the female bird these markings are absent; in the young of both sexes the under tail-coverts are entirely of that colour. The male has the chestnut-red pectoral markings more distinct than in the female. In the young bird they are considerably diminished, each feather having only a minute touch of rufous, with a spot of black beyond, imparting to the breast a speckled effect. The irides of the young bird, which are originally dark, change rapidly to a dull olivaceous-yellow, which becomes golden at maturity. The old birds on being caught utter a peculiar rasping cry; the young has a similar

note but weaker, and when alarmed emits a distinct squeal. The ordinary note of the species is a sibilant whistle, whence it derives its native name, "Wio." (These notes were taken from three birds obtained from the upper waters of the Waikanae River, and forwarded alive to Europe.)

Podiceps rufipectus, Gray. (The New Zealand Dabchick.)

This interesting little bird is still numerous on the lagoons of the west coast of this province, where, indeed, it appears to be increasing. The pairing season commences in September, and the birds become then very noisy, chattering to each other across the water all day long. At this season it is very amusing to witness the amorous gambols on the water of these otherwise sedate swimmers, with their backs arched and feathers fluffed out, splashing about and chasing each other in the wildest state of excitement.

Eudyptes antipodum, Hombr. and Jacq. (The Yellow-crowned Penguin.)

A correspondent, who had one of these Penguins alive for some time, sends me the following note: "When excited it has the habit of erecting all the feathers on the front of the head, and as far back as the yellow band. When thus seen the silky lustre and varying shades of bronze down the sides of the neck are very beautiful."

Eudyptes vittatus, Finsch. (The Thick-billed Penguin.)

Of this rare species I have lately received a fine adult pair from the Southland coast.

Eudyptes sclateri, Buller. (The Auckland Islands Penguin.)

Of this Penguin, hitherto only known as occurring on the Auckland Islands, I have obtained an adult pair recently killed on the Otago coast.

Pygoscelis tæniatus, Peale. (The Rockhopper.)

My authority for including this Penguin among the birds of this country was a pair in the Otago Museum, obtained from Macquarie Islands, where this bird is said to be plentiful. Dr. Kidder found it very abundant in Kerguelen's Land. He writes, "Two or three of the birds were captured by the boat's crew which went on shore after the eggs, and brought back to the ship, where they created a good deal of amusement. When walking away from the spectator, swaying from side to side, with flippers hanging well away from the body, they have a ridiculous resemblance to small children just beginning to walk, who have put on overcoats much too long

for them. . . . No living thing that I ever saw expresses so graphically a state of hurry as a Penguin when trying to escape. Its neck is stretched out, flippers whirring like the sails of a windmill, and body wagging from side to side, as its short legs make stumbling and frantic efforts to get over the ground. There is such an expression of anxiety written all over the bird; it picks itself up from every fall, and stumbles again, with such an air of having an armful of bundles, that it escapes capture quite as often by the laughter of the pursuer as by its own really considerable speed. On the 3rd December, about the time of hatching, I observed a school of these Penguins progressing by leaps clear of the water; one following another in so rapid succession that two or three were always in the air, and with a motion so like that of porpoises that I at first took them for those marine mammals. In the water, indeed, all awkwardness at once disappears, their speed in swimming being almost incredible, and surpassing, of course, that of the fish upon which they feed. On the 4th December I found one young Penguin just hatched, and three more still in the eggs, which they had broken with their beaks. The young are covered with soft, hairy, pearl-grey down; head black, above and behind."

Aptenodytes longirostris, Scop. (The King Penguin.)

In connection with the full account which I gave of this species, from Macquarie Island, in last year's volume, the following note by Dr. Kidder is worth reproducing. I commented on the extremely gentle nature of my birds; Dr. Kidder's experience with one, at least, on Kerguelen's Land appears to have been different. He says, "The first specimens of this Penguin found near our station were met with on the beach on the 26th November, having apparently just come out of the water. There was but a single pair, both of which were secured, one being brought home alive. The other fought so fiercely that I had to kill him to get him home. . . . I endeavoured to keep the other alive, tying it up on the beach with a good long line to its leg. It would spend a large part of every day, at the end of its line, splashing in the water. It finally entangled itself in the seaweed near the bottom, and was drowned during the night. It slept bolt upright, balanced on its heels, swaying back and forth as it breathed, and snoring heavily. The neck is very extensible, so much so that the bird can stand at least a foot taller when excited than when at rest. It will frequently remain for twelve hours standing in the same place, and seems to me to be in every way a stupider bird than either *Pygoscelis* or *Eudyptes*. When thrown down it raises itself by aid of its beak, pressing the point against a stone. . . . Captain Fuller, of the

schooner 'Roswell King,' informs me that they build no nests whatever, carrying the egg about in a pouch between the legs, and only laying it down for the purpose of changing it from male to female. The pouch, if there is one, can be no more than a fold of the skin, since none was noticed in skinning or measuring the specimens."

In my account of this species ("Birds of New Zealand," vol. ii., pp. 306, 307) I omitted to mention, on the authority of Professor Hutton, that in 1878 a live one was taken on the coast at Moeraki, and forwarded to the Otago Museum.

Apteryx bulleri, Sharpe. (The North Island Kiwi.)

Of late a good many examples have been obtained in the wooded district south of New Plymouth, which is fast being occupied by settlers. In August last a nest containing two eggs was discovered by a man who was felling bush on the property of Messrs. Stretton and Jobson. These specimens are now in Mr. Drew's interesting little museum at Wanganui, and one of them, before being emptied of its contents, was found to weigh 15oz. 90gr.

Examples from certain localities are very dark in their colouring, being almost black, even the tarsi and toes being brownish-black.

Apteryx australis, Shaw. (The South Island Kiwi.)

I recently received a live example of this species from Milford Sound, and kept it for a time in my enclosure. At a glance its distinctness from *Apteryx maxima* was apparent. Its white-horn-coloured bill and its flesh-white feet, the streaky character of the plumage, owing to a light-brown stripe down the centre of each feather, irrespective of its smaller size, make it readily distinguishable from the last-named species. On placing the bird in the Kiwi-yard it was at home at once, retiring into the empty cask provided for it. In disposition this bird differs entirely from my other captive Kiwis —*Apteryx maxima, Apteryx haasti,* and *Apteryx oweni*—being far more fierce and aggressive. On approaching the cask, soon after he had taken up his quarters there, the bird came out and gave battle at once, even in the daylight, grunting angrily and striking forward with his feet, which are armed with very sharp claws.

This bird, although in excellent condition, died suddenly without any apparent cause. Possibly it accidentally got at some poison which had been deposited in a rat-hole. It gave the following measurements: Extreme length, to end of tail, 28in.; to end of outstretched legs, 34·5in.; culmen (measuring from anterior edge of fleshy cere), 5·25in.; along edge of lower mandible, 6in.; tarsus, 3in.; middle toe and claw, 3·5in.;

hallux, 0·75in.; largest circumference of foot, 3·75in.; rudimentary wing, from flexure to end of spur, 1·4in. The spur on each wing is a mere claw 0·25in. in length, and white with a greyish point. As already mentioned, the feet are white, but there are small brown scales on the heel and hind part of tarsus. The tarsus presents a regular line of angular scutella in front, and the claws are perfectly white. In all these points this species differs from *Apteryx maxima.* In addition to the features already recorded, which distinguish this bird from *Apteryx bulleri*, there is another which is worth mentioning: the feathers of the under-parts have the peculiar silvery or shining shafts characteristic of the moa-feathers which Mr. Taylor White collected some years ago at Queenstown.

Apteryx oweni, Gould. (The Grey Kiwi.)

I have received some specimens of this bird from Mr. J. Brough, of Nelson, differing from those obtained further south by the regular and distinct character of the barred and mottled markings on the plumage of both upper and lower surfaces. My correspondent says, "The birds sent are from the Upper Buller. This species inhabits the dense bush, and seems to prefer dark and gloomy gullies, where the sun scarcely ever penetrates, and where the underscrub is almost always dripping-wet. In such places you will sometimes get a whole colony. The most I ever got in one batch was twenty-six birds, at the head of a gully such as I have described. For feeding they select mossy ground with few stones. Their favourite places are where a young growth of birch-trees has replaced the old forest. Individuals differ, however, very much in their habits. You will see by the sharpness of their claws that the ground roamed over by these birds is very soft. They camp by day in holes of fallen trunks of trees, and come out in the evening to feed."

I had several of these birds in confinement, at the same time as the other species, and was impressed with their extreme gentleness of disposition as compared with *Apteryx maxima* and *Apteryx australis.* They are even more docile than *Apteryx haasti*, allowing themselves to be handled almost without resistance, seldom striking with their feet, and only expressing their alarm or annoyance by an audible snapping of the mandibles. They require, too, to be handled gently, as the feathers come out on the slightest rough usage.

Mr. C. Robinson, who has spent much time in the South Island collecting Kiwis, brought me lately for examination an egg of this species. It is broadly ovoido-elliptical, measuring 4·4in. in length by 3in. in breadth; milky-white, and with a slightly-polished surface, which shows a little discoloration

from contact with the bird's feet during incubation. He found it in a hole formed by manuka-roots, and well concealed by the grass; but the dog scented it out and killed the bird on the nest. This was in September, 1888.

Apteryx haasti, Potts. (The Large Spotted Kiwi.)

Lovers of natural history will be glad to learn that this very rare species of Kiwi from the South Island—of which there is only a pair in the Canterbury Museum, placed there twenty years ago, and not another known specimen in any other public museum, either in the colonies or in Europe—has been successfully introduced into the North Island. Some months ago I received a fine pair from the South, and, after keeping them for some time in my Kiwi enclosure in order to study their habits, I liberated them on a wooded island, a little over an acre in extent, near my homestead at Papaitonga. I placed on the island at the same time a pair of the small Grey Kiwi (*Apteryx oweni*), and, a short time previously, a single North Island Kiwi (*Apteryx bulleri*), kindly presented to me by Mr. Drew, of Wanganui, for that purpose. The locality is admirably suited to such an experiment, the ground being similar to that which the Kiwi frequents in its natural state, and well covered with native vegetation. Being on an island surrounded by a fresh-water lake about 150 acres in extent, and all within my private property, they are not likely to be molested in any way. But to prevent any chance of Maori depredations in the breeding-season I have also placed on the island three large live tuataras, kindly supplied to me by Captain Fairchild. The fame of these lizards, of which the Maoris have a most unaccountable dread, has spread far and wide. I have named them after three noted dragons of the past, Peketahi, Whangaimokopuna, and Horomatangi; and the Kiwis could not have three better guardians, for with this dread of the *ngarara* no Maori will ever willingly set foot on the island. The birds are apparently doing well, for their shrill calls—the male and female responsively—may be heard every night, the effect across the still waters of the lake being very pleasing. I had intended to add a pair of Kakapo (*Stringops habroptilus*) to this little island community, but, unfortunately, one of them died, and the other effected its escape before I could accomplish my object. I fear I shall not now have an opportunity of doing this till after my return from England. The Kiwis, however, may be looked upon as fairly established there; and it will be interesting to note whether, within their now circumscribed home, the three species will interbreed or not. An experiment of this kind could not be carried out under more favourable conditions, and I shall not fail to inform the Society hereafter as to the result.

In the Hon. Walter Rothschild's beautiful collection of New Zealand birds at Tring Park there are two partial albinoes of this species. They are male and female. The former has the crown of the head, face, throat, and an irregular narrow stripe down the fore-neck dull greyish-white; on the shoulder, breast, and back there are likewise a few scattered feathers of pure-white. The female, which is an exceptionally large specimen, has a broad, irregular, transverse band of yellowish-white on the under-part of the body; rest of the plumage normal.

From a fresh specimen I obtained the following measurements:—*Adult* ♀. Length, to end of tail 29in., to end of outstretched legs 41in.; culmen, from anterior edge of cere to the tip, 5·25in.; along the edge of lower mandible, from the angle of the mouth, 6·25in.; tarsus, 3·50in.; middle toe and claw, 3·50in. (the claw being 1in.); hallux, 0·75in.; median circumference of tarsus, 2·50in.; circumference at junction of phalanges, 4·25in.; humerus, 2in.; cubitus, 1·50in.; spur, 0·25in.

Art. XI.—*On the Fissures and Caves at the Castle Rocks, Southland; with a Description of the Remains of the Existing and Extinct Birds found in them.*

By A. Hamilton.

[*Read before the Otago Institute, 10th May, 1892.*]

Plates VII., VIII.

A few miles south of Lumsden, on the right bank of the Oreti River, Southland, an outcrop of limestone occurs at a place called the Castle Rocks. Here denudation has exposed the beds of limestone, which are tilted at a high angle, and huge masses of rock have become detached, and have fallen, slipped, or rolled to a resting-place on the spurs of the steep hillsides or down to the valley beneath. The enormous size of the blocks, and the confusion in which they are piled, recalls many a memory of ancient and picturesque ruins on historic sites.

In this part of the world we are but now making history, and comparatively little of Nature's record of past centuries has yet been read. Hidden in these Castle Rocks my friend Mr. Mitchell and I have been privileged to find a very interesting, even if still imperfect, chapter of the unwritten record of the past.

For convenience I shall use the first person in writing these notes; but it must be understood that Mr. Barnhill, of the

Castle Rocks Station, and Mr. Mitchell, of Manipori, have co-operated with me and rendered me every assistance in the exploration of the caves, and that I am deeply indebted to them for their help.

Mr. Mitchell having found some bones of *Aptornis defossor*, Owen,* in some caves amongst these rocks some years ago, I was induced to visit the place, and, after some little search, found that there were two places which yielded small bones of birds other than moa. One place was at the bottom of a deep water-worn cave, far down under the rocks, the bottom of which was a stiff, yellow, wet clay; and the other, a more promising-looking place, nearly on the top of a hill, was a naturally-formed trap or pitfall for apterous birds. The descent into this pit was perhaps 25ft. or 30ft. Small trees and bushes were growing close to the mouth, and a long vine or stem of the *Rubus* served as a rope by which to descend into the pit or chasm. The greater part of the floor was covered with a stiff, greasy-looking brown earth, somewhat irregular on the surface, and in many parts hidden by the dead leaves, dry twigs, and sticks that had fallen or blown into it. I was surprised to see sticking out from the *débris*, under the sloping surface of the rock on the lower side, a number of bird-bones, and still more surprised and delighted to find that, by scraping up the ground with a pick, bones could be obtained in great numbers. I must now try to describe more particularly and definitely the character of the chasm or fissure.

The sides were formed by two enormous blocks of the limestone imbedded on their edges, with the planes of stratification or fracture nearly parallel, but both tilted at a considerable angle. The upper end of the chasm was closed by irregular blocks of limestone, and also the lower end, but not to the same level. The chasm is only accessible from this lower end. The length was about 50ft., and the average breadth 8ft. The rock on the right of the entrance sloped at a somewhat greater angle than the one on the left, so that the width increased a little towards the bottom.

A reference to the plan and sections on Plate VII. will give an idea of the place.

The general result of the digging in this pit was that the bones were only found along the underface of the rock on the right hand, and chiefly in the light friable mould formed by the decay of the leaves and vegetable *débris*; and this, mixed with the limestone dust and efflorescence, proved to have preserved even the most delicate bones in perfection. On the left-hand side the soil was stiffer, and full of bird-guano and clay; very few bones were found in it. A reference

* See Trans. N.Z. Inst., vol. xx., p. 175.

to the section will show that at A and B there were two distinct layers of guano thickly studded with the smaller bird-bones, and much hardened and consolidated, possibly by the trampling of birds. The space marked C, as mentioned above, contained the best bones, but all in the greatest confusion: only in a few instances did we obtain anything like a complete skeleton of any bird with the bones in approximation.

On our last visit we went to a depth of 8ft. at C, and got bones in profusion. Much as I wished to do so, we found it impossible to go deeper, as the earth above would keep coming in on us. At D we found a hollow, or open shelter, which was almost if not quite closed with the accumulated earth. A large number of bones were got from this part.

At E, some little distance under the surface, Mr. Mitchell found a crevice which appeared to lead into another cave. The prospect of a new and untouched deposit fired us with the greatest enthusiasm, and we dug the soil away till the aperture appeared; but, alas! it was only 9in. wide at the mouth—much too narrow for either of us to squeeze through. Placing a lighted candle on the end of a long stick we pushed it in and saw a cave, not very large, but very pretty, as the floor was thickly covered with bird-skeletons all covered with the pure-white efflorescence from the limestone roof, like snow. Great expectations were formed as we took it in turns to hammer at the narrow opening with my geological pick, and, after more than an hour's work and numerous trials, Mr. Mitchell, being an inch or so less than I, managed to wriggle in on his side. He then gathered up the bones and passed them out to me, literally in "hatfuls."

The floor of the short passage, which widened a little after the entrance, was very hard, as if trodden down by the passage of birds.

The end of the little cave was a small irregular chasm, descending vertically, which was too small to examine properly.

At F, at the other end of the cave, there was another lateral opening, 10ft. or 12ft. high at the mouth, and extending perhaps 20ft. This was covered on the floor with soft crumbly stalagmitic deposit, but no bones were found in it.

As the result so far of our examination, I find that, of still-existing birds of flight, a considerable number of species are represented, but naturally only in small numbers. They include owls, hawks, crows, petrels, and some of the smaller perching-birds. The distinct group of birds which we call in general terms moas was well represented by the species living in that part of the country, and some excellent skeletons of some of the smaller species were obtained, and some instructive specimens of immature birds, which promise to yield interesting information on obscure points.

The character of the deposit was such that our examination of it was necessarily slow and minute, the bones being found in such a confined space: it is therefore somewhat surprising that not a single fragment of eggshell of any kind whatever was found by us. In the Earnscleugh cave, I believe, numerous fragments were found both of duck and moa eggshell.

The bones themselves were exceptionally well preserved, only two small patches being found where the bones were perished through damp.

The scattered condition of the bones of the smaller birds may, I think, be accounted for by the probability that wekas (and kiwis) lived for some time after their being entrapped—as long as there were dead birds, or weak individuals which might be killed, on which they could live.

To account for the male and female of the giant eagle (*Harpagornis*) being present is almost as difficult as to account for their presence in all the large finds of moa-bones. They may have had their nest on the top of the rock, and it is quite possible that they may have been tempted in by the carcase of a dead moa, and then have found that in the narrow space between the rocks they were unable to spread their wings for flight, and thus perished miserably.

In all open fissures or chasms of this kind we may expect to find intrusive deposits: I was therefore not surprised to find the bones of a sheep at and near the surface; also, at a lower depth, close to the rock, the skull and remains of a polecat ferret;—no doubt accidental victims during the "sheep period." No trace of man's handiwork was found, either in the form of stone tools or of intentionally-broken bones. Some of the bones near the top of the leafy deposit at C had been slightly burnt—in all probability from sparks from the frequent grass-burnings in the neighbourhood, or from the matches of visitors at an earlier date than our exploration.

From inquiries I find that this place has been known for many years to settlers in the neighbourhood, rabbiters, and others, and that numbers of the most noticeable bones have been collected at various times, but not preserved. It is difficult to express one's feelings on this matter, and I deeply regret that the specimens have all perished, as from what we found remaining it is probable that almost priceless treasures have been destroyed heedlessly. Mr. Savage, who was my guide on the first occasion, collected a number of bones some years ago, and transmitted them to a museum in Scotland. To his intelligent interest in the matter I owe much valuable information. I have undertaken to examine and report upon the very large number of bones which the chasm yielded to our digging, and I now propose to give a short account of the most

important of the species at present recognised among the remains.

Harpagornis.

Pride of place will certainly be yielded to the great extinct eagle, first made known by the excavations of Sir Julius von Haast at Glenmark, and described by him twenty-one years ago (1871). Very few bones have since been found, except at Hamilton Swamp and Enfield. I was therefore much pleased when I found very near the surface the ulna of *Harpagornis*, and shortly after one of the huge claws, or ungual phalanges. Piece by piece we found most of the important bones of the body, and on the last day of our digging we found the long-looked-for skull, nearly perfect. Up to the present time only two very much broken crania have been found—one at Motunau, and the other, rather more perfect, at Enfield. Strangely enough, none of the bones found were duplicates, till just at the last a second right coracoid, much larger than usual, was found, thereby implying the presence of two skeletons, and giving hope that further research will be rewarded.

Harpagornis moorei, Von Haast.

Skull.—Fragments known:—

1. Basal portion, much broken, from Motunau, North Canterbury; in Colonial Museum, Wellington.*
2. Fairly perfect calvaria, from the deposit of bones exhumed by Mr. H. O. Forbes at Enfield, near Oamaru, Otago, 1891.
3. Skull and upper mandible, nearly perfect, with right quadrate, from Castle Rocks, Southland.

There is a lower mandible of *Harpagornis* in the Christchurch Museum, from the Hamilton Swamp. From its measurements I should assign it to *H. assimilis*. Extreme length, 113mm.; extreme width at articulation, 74mm.

Vertebræ.—From Castle Rocks:—

Cervicals, 4.
Dorsals, 6.
Caudals, 3.

Pelvis.—From Castle Rocks: Length, 7·27in. (180mm.); greatest breadth, 3·25in. (75mm.).

The pelvis in the Colonial Museum is from Otago, and was found by Mr. Low.† It measures 7·22in. in length, and 3·38in. in width. The specimen has been figured by Haast and by Owen.

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* Rep. Geol. Surv. N.Z., 1883, p. xx., and p. 76.

† Trans. N.Z. Inst., vol. iv., p. 114 (footnote); Trans. N.Z. Inst., vol. vi., p. 71, pl. ix., figs. 1, 2, 3. Owen, "Extinct Birds of New Zealand," vol. ii., pl. cv., figs. 1, 2, 3.

H. assimilis: A fragmentary pelvis is recorded in the Transactions* as having been found at Glenmark, and is one of the types in the Canterbury Museum. The extreme length of the sacrum is 122mm. It is too much broken for further measurements. The sacrum of the Castle Rocks specimen measures 136mm.

Sternum.—Mr. Forbes has had, I believe, the pleasure of discovering this bone at Enfield.

Coracoid.—Two specimens of this bone were found at the Rocks, and, being both from the same side, indicated the presence of two birds.

1. Total length, 106mm.; greatest width at base, 52·5mm.
2. " " 90mm.; " " 50mm.

As the coracoid of the smaller sex of *Harpagornis* has not yet been recorded, we may for the present assign No. 2 to *H. assimilis*, which is in all probability, as suggested, the male of *H. moorei*. Should, however, a still smaller coracoid occur, the determination will be doubtful, and the difference will only be of an individual character.†

Scapulæ.—The right and left scapulæ were obtained in the course of the excavations at Glenmark.‡ These were, I believe, of *H. moorei*, as on p. 63 the left scapula of *H. assimilis* is mentioned as part of the result of further excavation. No measurements are given of these.

At the Castle Rocks the right and left scapulæ were found of what I take to be *H. moorei*. The extreme length in a right line is 134mm.

Furculum.—The specimen I found I unfortunately broke with the pick, and though I searched carefully I could not find the remaining portion. The fragment shows the very robust character of the bird. The bone has not been recorded before. There is, however, a cast of a fragment of a furculum in the Canterbury Museum; the locality of the original is unknown—possibly Enfield.

Humerus.§—A very perfect humerus was found in the stiff brown earth at the upper part of the cave. It measures: length, 240mm.; circumference, 55mm. This is probably the humerus of *H. moorei*, as the humerus of *H. assimilis* is given as 223mm. (8·57in.). I have examined the types in the Canterbury Museum, and I make the measurement

* Trans N.Z. Inst., vol. vi., pp. 66, 71, and 73.

† There is a cast of a coracoid in the Canterbury Museum, locality unknown—possibly Enfield—measuring 84mm. This might also be of *H. assimilis*.

‡ Trans. N.Z. Inst., vol. vi., p. 62.

§ Trans. N.Z. Inst., vol. iv., p. 195: fragment of right humerus, Glenmark Creek. Owen, "Extinct Birds of N.Z.," p. 145. *H. assimilis:* Trans. N.Z. Inst., vol. vi., p. 69, pl. viii., figs. 1, 2 (lettered in error *H. moorei*). Owen, "Extinct Birds of N.Z.," pl. cvi., figs. 1, 2.

216mm., or 8·42in. Besides this bone there are two fragments, one of the distal end of a humerus and the other of the proximal end, in the Canterbury Museum.

*Ulna.**—This bone was also found perfect at Castle Rocks. Its length was 259mm., which is nearly the same as the right and left from Glenmark—10·06in., as given in the Transactions.

Having recently measured the type specimens in the Canterbury Museum, and some from Enfield and Hamilton, I give the dimensions:—

H. moorei.

	in.	mm.	
Glenmark, R., type, mended, length	9·9 :	250	Cant. Mus.
〃 L., 〃	9·9 :	250	〃
Hamilton, R.	9·0 :	255	Otago Univ. Mus.
Castle Rocks, R.	..	259	

H. assimilis.

	in.	mm.	
Glenmark, L., type†	9·25 :	232	Cant. Mus.
〃 R., 〃	9·3 :	235	〃
Hamilton, R.	9·0 :	230	〃

Radius.‡—Found on the surface, at the extreme end of the cave, under the overhanging rock. Length, 246mm.

There is a radius in the Canterbury Museum from Enfield measuring 235mm. These two will probably belong to *H. moorei.*

The type of *H. assimilis* is given in the Transactions as measuring 7·62in. (Trans. N.Z. Inst., vol. vi., p. 71), but from my measurement I make it 8·6in., or 219mm.

Metacarpus.§—One perfect metacarpus was obtained, and, as it measures 126mm., it will probably belong to *H. moorei*, the metacarpal of *H. assimilis* being given as 4·48in. (about 105mm.); I find the type, however, to measure 113mm.

Carpus.—I found a small bone, which I take to be the carpus, when sorting over the smaller fragments from the cave.

Femur.‖—Unfortunately we have not yet found in the cave a femur of *Harpagornis.* Von Haast gives the length of the femur of *H. moorei* as 6·66in. (166mm.); Glenmark.

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* Trans. N.Z. Inst., vol. vi., pp. 62, 63, 70. *H. assimilis:* Trans. N.Z. Inst., vol. vi., pp. 63 and 70, pl. viii., figs. 3, 4. Owen, "Extinct Birds of N.Z.," pl. cvi., fig. 3, p. 145.

† The left ulna of the type of *H. assimilis* is slightly abnormal at the distal end.

‡ Trans. N.Z. Inst., vol. vi.: fragment of left radius. *H. assimilis:* Trans. N.Z. Inst., vol. vi., p. 71, pl. viii., figs. 5 and 6.

§ Trans. N.Z. Inst., vol. vi., pp. 63, 64, 71, pl. viii., fig. 7. Owen, "Extinct Birds of N.Z.," p. 146.

‖ Trans. N.Z. Inst., vol. iv., p. 193, pl. x., fig. 1: left femur. "Geology of Canterbury and Westland," p. 444. Broken femur in bed 5, peat, Glenmark: Trans. N.Z. Inst., vol. vi., pp. 64, 65.

H. assimilis:[*] A right and left femur were found in the deposit of the Glenmark Creek, and the measurement is given at 6·09in. (146mm.). I make it 155mm. There is a femur of *H. assimilis* in the Otago University Museum, from Hamilton, which measures 147mm.

Tibia.[†]—Only one tibia was recovered, but that was in most perfect preservation. It is slightly longer than the Glenmark specimen, being 249mm. The right and left of both species seem to have been found at Glenmark (pp. 62, 63). These specimens measure 9·3in. (or 236mm.) and 9·4in. (or 239mm.). The same bone in *H. assimilis* is 8·92in. (227mm.) in length. In the type of *H. assimilis* the articulating surface is too much destroyed to allow of accurate measurements being obtained; the length is, however, approximately correct. A specimen from Hamilton, also in the Canterbury Museum, more perfect, but still wanting a process, measures 8·25in. (210mm.).

Fibula.[‡]—Two fibulæ were found, one much broken. Those found at Glenmark are supposed to be of *H. moorei*.

Metatarsus.[§]—One right metatarsus was found at the Rocks. It measures 162mm., being slightly longer than the Glenmark type, 6·08in. (155mm.). The breadth at proximal end is 40mm.; at distal end, 44mm. I have a specimen from the Dunstan Range measuring 158mm., and one from the Maori middens at Warrington, 137mm.: this latter, however, will be probably *H. assimilis*,[||] which Von Haast gives as 5·87in. (150mm.).

Metatarsus of H. moorei.

	Length.	Breadth. prox. end.	Breadth. distal end.	
	mm.	mm.	mm.	
Glenmark types	155	37	42	2 specimens, R. and L.
Castle Rocks ...	162	40	44	
Dunstan ...	158	38	43	
Enfield ...	155	38	42	Cant. Mus., R.

Metatarsus of H. assimilis.

Glenmark type	148	32	37	Cant. Mus.
Hamilton ...	148	31	37	"
Warrington ...	137	30	36	

* Trans. N.Z. Inst., vol. vi., pp. 63, 65. Owen, "Extinct Birds of New Zealand," p. 146, pl. cvii., figs. 1, 2.

† Trans. N.Z. Inst., vol. vi., pl. vii., figs. 1, 2, p. 66. Owen, "Extinct Birds of New Zealand," p. 147, pl. cvii., figs. 5, 6.

‡ Trans. N.Z. Inst., vol. vi., pl. vii., figs. 3, 4, pp. 62, 67.

§ Trans. N.Z. Inst., vol. vi., pl. vii., figs. 5, 6. Owen, "Extinct Birds of New Zealand," p. 147, pl. cvi., figs. 5, 6.

|| Trans. N.Z. Inst., vol. vi., pp. 63, 64, 70.

*Phalanges.**—Those recovered were four ungual phalanges,† and most of the bones of one foot.

Ribs.‡—About fifteen ribs, more or less perfect.

Passing over the remains of still-existing flying-birds, a list of which will be given at the end of this paper, we will next take a very important group of Ralline birds in which the power of flight is feeble, if not altogether lost, and which contains some of the most interesting forms included in the New Zealand ornis.

Notornis.

One of the forms which some of us have been permitted to see in the flesh is *Notornis mantelli* of Owen, or *Notornis hochstetteri* of Meyer, otherwise known as the takahe. Perhaps it is the fact that we have actually evidence, from living specimens, of its plumage and appearance, that gives it quite a popular interest, to say nothing of the actual value as a museum specimen.

The cave yielded the remains of three of these birds, two of the skulls and the set of limb-bones being nearly complete, one of the skulls being in an exceptionally fine state of preservation.

I have given a table of measurements below, by which it will be seen that the measurements of the principal bones closely agree with those of Von Meyer and Professor Parker, and differ largely from Professor Owen's Waingongoro specimens, thereby supporting the idea that there must have been some error in the determination of some of the type bones, or that the North Island species is much larger. The only remains that I obtained at Te Aute correspond more nearly with the southern bones than those of Waingongoro. The measurements of any bones from the original locality in the North Island would be of great interest. Recently I obtained three metatarsals from a Maori midden at Longbeach, near Dunedin, which fact would perhaps indicate that at one time this stately bird was not uncommon, and was valued as food. A

* Trans. N.Z. Inst., vol. vi., pp. 62, 175. Casts of the type bones of *Harpagornis* are in the British Museum, and are mentioned in Lydekker's Catalogue, 1891. The only original bone at that date in the Museum collection was one from Waingongoro, in the North Island of New Zealand: "the proximal phalangeal of the second digit of the right manus" (No. 32245*h*). On page 26 the notice of the original types states that they are in the Museum at Wellington. The pelvis of *H. moorei* is the only one of the types in the Colonial Museum; the rest are in the Canterbury Museum.

† Trans. N.Z. Inst., vol. iv., p. 195, pl. xi., figs. 1, 2. Trans. N.Z. Inst., vol. vi., pp. 62, 63, and 75. Owen, "Extinct Birds of New Zealand," p. 148, pl. cvii., fig. 7.

‡ Trans. N.Z. Inst., vol. iv., p. 194, pl. xi., fig. 5. Trans. N.Z. Inst., vol. vi., pp. 62, 63.

pelvis of *Notornis* was obtained from the Earnscleugh Cave, and is now in the Canterbury Museum.

MEASUREMENTS OF NOTORNIS.

—	*N. mantelli*, Owen; British Museum.	*N.* Henry's Skeleton; Dunedin Museum	*N. hochstetteri*, Von Meyer; Dresden Museum.	*N.* Castle Rocks, No. 1.	*N.* Castle Rocks, No. 2.
Skull—	mm.	mm.	mm.	mm.	mm.
Length, from posterior surface of occipital condyle to end of beak	..	98	..	104	100
Greatest breadth	..	45	45	42·5	41·5
Humerus—					
Length	..	90	87·5	82	..
Breadth of head	..	21	23·5	20	..
Breadth of condyles	..	15·5	18	14	..
Circumference of shaft ..	..	19·25	16	..	..
Ulna—					
Length	..	75	75·5	..	..
Breadth of proximal end ..	..	14	13·8	..	..
Breadth of distal end	..	9	8·7	..	..
Femur—					
Length	122	111	109	110	106
Breadth of proximal end along axis of neck	..	24·5	27	..	23
Breadth of distal end		24	27	24	23
Circumference at middle of shaft	..	34	34	..	..
Tibia—					
Length	200	163	165	164	160·5
Breadth of proximal end ..	..	32	31	31·5	28
Breadth of distal end	..	18	22	17·5	17
Circumference at middle of shaft	..	29·5	29	25·5	24
Fibula—					
Length	..	..	..	..	..
Breadth of proximal end ..	..	..	12·2	12	..
Tarso-metatarsus—					
Length	129	98	100	108	98
Breadth of proximal end, transverse	..	19·5	22	19·5	20
Breadth of antero-posterior ..	..	..	24 3	22	21·5
Breadth of distal end	..	21·5	23	21	21
Breadth of shaft	..	10·2	10	9·5	9·5
Sternum—					
Greatest length	..	74	75·5	72	72
Length of median longitudinal axis	..	62	66	64	63
Height of keel	..	9	8	6	7
Coracoid—					
Greatest length	..	47	43·5	45	43
Scapula—					
Length in a straight line ..	..	74	74·5	72	..
Pelvis—					
Greatest length	..	117	130	124	125
Greatest width	..	54	55	52	53
Greatest width of sacrum ..	..	23·5	23	25	26

Fulica.

Quite recently Mr. H. O. Forbes has announced in the newspapers the discovery of a curious Ralline form (*Aphanapteryx ?*) in the Chatham Islands, and with it he found bones of a coot (*Fulica*), which he describes as "closely allied to *Fulica newtoni*, found at the Mauritius with the *Aphanapteryx* and the dodo."

Our cave has produced abundant evidence that we have had here in this Island a large *Fulica*, also closely allied to, if not identical with, *Fulica newtoni*. I have now a considerable number of bones of nearly all parts of the skeleton, including three crania. (See Table below.)

It is possible that further investigation may prove that, notwithstanding the great distance separating the localities—half the circumference of the globe—the species is *F. newtoni*. As, however, it will be convenient to have a name for this species, I propose calling the *Fulica* from Castle Rocks *F. prisca*.

It must have been a bird nearly as large as the *Notornis*, but with a small head, and a frontal shield like the pukeko and *Notornis*. There is evidence to show that *F. newtoni* had a white shield, and was of a black or brown colour. Like its congener, it was probably a bad flier but a good swimmer. The genus is not represented in our list of existing birds, but Mr. Colenso has described* a small bird probably of this group, which he met with many years ago on the Waikato River.

I have also had a report from a sportsman who killed a small bird answering to Mr. Colenso's description in a swamp near Wanganui, but by an accident the specimen was lost. On the Australian Continent, Mr. De Vis, of the Queensland Museum, has described and figured† a fossil humerus from the Chinchilla deposits of the Darling Downs, as *Fulica prior*. As it is uncertain whether the two fragments belong to the same bone, measurements could not be taken, but it is evidently much smaller than the New Zealand species. The range of variation in the measurement of the bones of the legs obtained in the cave is considerable, but Günther and Newton,‡ in their note on the Mauritian species, do not let a difference of 20mm. in the tibiæ of full-grown birds (a seventh of the length of the longest specimen) deter them from including in one species these widely different figures.

* Tasmanian Journal Nat. Science, 1845.
† P.L.S. N.S.W., vol. iii., pl. xxxv., figs. 9*a*, 9*b*.
‡ Phil. Trans. R. S. Lond., vol. clxviii., p. 434.

FULICA PRISCA.

Femur.

—	mm.	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
Specimen No. 1	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 2	..	..	..	..	..	..	..	..	..	..	..	x	..	x	..	..	..
" 3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 4	..	..	..	..	..	x	..	..	..	x	..	..	..	..	..	..	..

Tibia.

—	mm.	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162
Specimen No. 1	..	..	x	x	x	..	..	..	x	..	..	..	..	..	..	x	..	..	..	..	..
" 2	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	x
" 3	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..
" 4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Metatarsus.

—	mm.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
Specimen No. 1	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..
" 2	..	..	..	..	..	..	..	..	x	..	..	..	x	..	..	..	..	..	..
" 3	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 4	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..

NOTE.—In all these tables of measurements only bones of apparently adult birds in good condition were taken for measurement.

I have lately had an opportunity of measuring a series of bones of the *Fulica* from the Chathams. The tibiæ ran from 152mm. to 163mm., the eighteen specimens being thus a trifle larger than *F. prisca*.

APTERYX.

Naturally, the kiwi remains constitute a large proportion of the bones found. Once having entered the chasm, escape was hopeless, and sooner or later his remains were added to the mass.

The majority of individuals seem to have been adults of the two species still to be found in the fastnesses of the wild West Coast, *A. australis* and *A. oweni*. The remains of the two species are easily distinguished, and, as the series of leg-bones is much larger than any collection hitherto made, I have given the measurements of all the perfect bones belonging to adult individuals, in diagrammatic tables, which will show at once the range of variation. The range of variation in the form and size of the sternum is very interesting, and, within certain limits, exhibits many forms.

The series bears out the new diagnostic character of the anterior border of the corpus sterni proposed by Professor Parker, in a paper on the development of the *Apteryx*,* that of the smaller species, *A. oweni*, being sinuously, and of the larger, *A. australis*, evenly, emarginate. Two of the larger ones show distinct thickening in the median line, and in five there is an irregular foramen on the right side of the postmedian process.

Out of the fifty or sixty examples of *A. australis* I have not noticed any variation in the number of facets for the ribs; but in the specimens of *A. oweni* there are two in which only three pairs were apparently attached.

The postmedian process in *A. oweni* seems to be always entire, and rarely with any indication of a notch. In *A. australis* the process is generally deeply divided in an irregular manner.

Mr. Lydekker, in his "Catalogue of the Fossil Birds in the British Museum" (1891), constitutes a new genus (*Pseudapteryx*) from a solitary metatarsus from the Mantell collection, "which corresponds to *A. oweni*, with the exception that the outer foramen above the tubercle for the tibialis anticus is placed on a much lower level than the inner one, and there is no depression on the anterior surface of the shaft, there is no foramen in the groove between third and fourth trochleæ, but a distinct channel above the groove."

The material under notice enables one to definitely reject the proposed genus, as I find that there are five metatarsals which have no foramen in the groove between the third and fourth trochleæ. Of these, three are right and two are left.

No. 32237*a*, fig. 53*a*, p. 217, Brit. Mus. Cat., 1891—
Length, 59mm.
Width (prox.), 15mm.

* Phil. Trans. R. S. of Lond., vol. clxxxii. B, p. 84.

Castle Rocks—
Length—*a*, 62mm.; *b*, 59mm.; *c*, 60mm.; *d*, 65mm.; *e*, 62mm.
Width—*a*, 21mm.; *b*, 19mm.; *c*, 20mm.; *d*, 21mm.; *e*, 20mm.

The position of the group of foramina above the tubercle for the tibialis anticus is very variable, and in *A. australis* they are more or less deeply sunk in a pit. In *A. oweni* they are more apparent, and the two lower vary in position a good deal: numbers of cases can be found in which one is lower than the other. In *A. oweni* there is a strong ridge down the face of the bone from the attachment of tibialis anticus, in the majority of cases. From these variations I am convinced that the genus *Pseudapteryx* has been founded on an individual variation, and that the bone has no claim to even specific distinction.

Measurements of the Extreme Lengths of the Skulls of Apteryx australis.

Number of Specimens.		Length. mm.	Number of Specimens.		Length. mm.
1	..	128	1	..	146
1	..	130	1	..	148
1	..	132	1	..	162
2	..	133	2	..	164
1	..	134	2	..	168
2	..	135	2	..	169
4	..	138	1	..	172
2	..	143	1	..	175

This list shows the remarkable variation in the length of the skull of *Apteryx australis*. The measurements clearly show two groups, one from 128mm. to 148mm., and one from 162mm. to 175mm. These are probably sexual distinctions. Only skulls of apparently adult individuals were measured for this list.

I append some diagrams (Plates VII. and VIII.) representing the measurements of the long series of *Apteryx* bones obtained. The first table for each bone shows the number of specimens, with the length in millimètres. The second table shows the same divided into rights and lefts. Considering the mixed condition of the bones, and allowing for other circumstances, such as accidental fractures, &c., the correspondence of the two sides is practically equal. It should be again stated that all imperfect or non-adult bones were excluded.

MOA.

During the excavations I found several moa skeletons under circumstances of great interest, for in at least three instances the bones of the legs were found in such a position as to leave no doubt as to their belonging to the one individual—in two

cases still having even the slender fibula in position. The birds all belonged, with one exception, to the genus *Anomalopteryx*, one of the small-statured genera of moas. The exception was a femur of a true *Dinornis*, found in an adjoining cave. The skulls found have proved of value, as demonstrating the structure of the skull in young individuals, and have been worked up by Professor T. J. Parker, F.R.S., in his valuable paper on the skull of the moa. Whilst the examination of the skulls was proceeding the curious feather-pits on the occipital portion were observed,* and found to occur plainly on some of the specimens—probably the males. Two distinct types of sternum are found, and are assigned by Professor Hutton to *A. didinus* and *A. didiformis*. The splendid preservation of the bones has enabled two skeletons to be set up, which are very complete, and especially perfect in the skull region. One type of sternum has deep coracoid depressions, but no scapulo-coracoid has been recognised yet to go with them.

Remains of young and immature birds are plentiful, and may assist in the study of the pelvis and other bones.

Aptornis.

The remains of *Aptornis* were described by me in the last volume of the Transactions (vol. xxiv., Art. VII.), and I have nothing to add in this paper, as no other bones of this bird were found during the digging; all that were obtained were found near or at the surface. This is somewhat curious, as I fully expected to find some of the missing bones at a lower level.

Ocydromus.

The remains of the weka, or Maori hen, were naturally to be expected in a deposit of this kind; and the majority of the bones appear to have been of the existing species (*O. australis*), or possibly some of its varieties. The number of individuals represented is quite small when compared with those of the kiwi or kakapo, and the bird must have been at all times scarcer. At the present time it is so nearly exterminated by the progress of settlement and other causes that I have had considerable difficulty in getting bones of the South Island species for measurement. Doubtless wekas are still plentiful on the West Coast, but in the open country of the eastern side of the Island they are now scarce. In the North Island the species found there seems to hold its own, and in some parts of Hawke's Bay even to increase. It is interesting to notice that the south and south-west of the South Island are credited

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* See above, Art. II., p. 4.

with four or five species; there is only one in the North Island. It is in the South also that we find the greatest diversity in the development of the *Dinornithidæ* and *Apterygidæ.*

I have appended below a table of measurements of a series of bones of the northern species (*O. greyi*, Buller), from Hawke's Bay. The measurements of the rights and lefts in the individuals varied so little that I have not given separate measurements.

Ocydromus, sp.: There were indications in the remains from the cave of a species which coincides almost exactly with the measurements given by Von Meyer* of *O. sylvestris*, Scl., from Lord Howe's Island. The measurements show that it was much smaller, and the bones are proportionately more slender in all their parts than any other of the existing forms, and I had in the first draft of this paper proposed the name of *O. minor;* but I can hardly venture to inflict a fresh name without a larger series of measurements for comparison. The specimens in the collection are two pelves, seven femora, six tibiæ, and five metatarsals, and the upper portion of a sternum.

	Castle Rocks Specimen.	Von Meyer.
	mm.	mm.
Pelvis, extreme length	65	62·5
Pelvis, extreme width	28	25
Femur	64	63
Tibia	93	98
Metatarsus	53	51
Sternum, greatest breadth (pleurost.) ...	24·5	24·5

An account of the habits and history of *O. sylvestris*, Scl., is given in a recent memoir of the Australian Museum on Lord Howe's Island,† at page 13. The table on page 17 records this species as occurring in New Zealand as well as New South Wales. On page 18, however, it states that *Ocydromus* as a genus is not found in the Australian region. Possibly, however, the table may have been the victim of the printer, as in several instances the "species" is marked as occurring in New Zealand, but not the "genus"!

In the table of measurements of *Ocydromus* there is an example of a North Island specimen which approaches closely the measurements of *O. sylvestris* as far as length is concerned, but the difference in relative bulk is considerable.

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* Abbild. von Vog. Skel., iv. and v. Lief., Taf. xli., p. 33.

† Memoirs of the Australian Mus., Sydney: No. 2, Lord Howe's Island. 1889.

Ocydromus.

Femur.

— mm.	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
No. of specimens of North Island species ..	2	..	..	..	..	2	2	2	..	..	..	..	..	3	6	..	..	..
Skeleton *O. australis*, O. U. Mus. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..
Skeleton No. 4356, Vienna Mus. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..
Castle Rocks (*O. australis*) ..	..	..	..	..	..	..	..	..	..	..	..	3	5	..	..	..	2	..
Skeleton of *O. fuscus*, Vienna Mus. ..	..	..	..	..	..	..	..	o	..	..	..	..	..	..	..	..	..	..

Tibia.

— mm.	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
No. of specimens of North Island species ..	2	..	..	..	..	..	..	4	..	..	..	..	..	..	2	..	2	2	2	4	2	..	..
Skeleton of *O. australis*, O. U. Mus. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..
Skeleton No. 4356, Vienna Mus. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
Castle Rocks (*O. australis*) ..	..	..	..	..	..	..	..	..	3	..	3	..	..	..	2	..	1	..	..	..	..	..	1
Skeleton of *O. fuscus*, Vienna Mus. ..	..	..	..	..	..	..	..	..	o	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Metatarsus.

— mm.	53	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
No. of specimens of North Island species ..	..	2	..	..	..	..	4	..	2	..	..	4	6	..	..	2	..	..	..	..	..	..
Skeleton of *O. australis*, O. U. Mus. ..	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..
Skeleton No. 4356, Vienna Mus. ..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Castle Rocks (*O. australis*) ..	..	..	..	1	1	4	..	3	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Skeleton of *O. fuscus*, Vienna Mus. ..	o	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

STRINGOPS.

Of this curious bird we found a large series of bones which will afford an opportunity of studying the osteology of this form of degenerate parrot. In the table of measurements I have placed a mark (o) at the average measurement of each.

STRINGOPS.

Femur.

mm.	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
Specimen No. 1	x	..	..	..	..	x	..	o	..	..	x	..	..	..	x	..	..
" 2	..	..	..	..	x	..	..	..	x	..	..	x	x	..	..	..	x
" 3	..	x	x	..	..	..	..	..	..	x	..	..	..	..	..	..	..
" 4	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..
" 5	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..
" 6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..

Tibia.

mm.	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132
Specimen No. 1	x	..	x	..	..	..	..	..	..	..	x	..	o	..	x	..	x	x	..	..	x	..	..	..	x	x	x
" 2	..	..	..	..	..	..	x	..	..	..	..	x	..	..	..	x	..	..	x	..	..	..	..	x	..	..	..
" 3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 4	..	..	..	..	x	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 5	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	x	..	..	..	..
" 6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 7	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Metatarsus.

mm.	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Specimen No. 1	..	..	..	o	..	..	..	..	..	..	..	..	..	..	..	..
" 2	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..
" 3	x	x	..	..	x	x	x	x	..	..	..	..	..	..	..	..
" 4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" 5	..	..	..	x	..	..	..	..	x	..	..	..	..	..	..	..
" 6	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..

Anas finschi.

In 1876 Van Beneden described* an extinct duck, under the name of *A. finschi*, from the large series of bones found in the Earnscleugh Caves, and an abridged account was communicated by Dr. Hector to the Transactions of the New Zealand Institute.† It seems to have been a common bird in localities such as the Castle Rocks and the Earnscleugh Caves. It is not unlikely that it may have bred in such places, or have had the habit of some of the Dendrocygnas of Australia. Quite 40 per cent. of the bones must have been duck-bones. The measurements of long series of these bones give an interesting diagram (Pl. VII.). To account for the great number of such birds it has been suggested that perhaps the eyrie of the *Harpagornis* was on the rock above the chasm, and that these are the relics of his foraging expeditions.

Coturnix.

Of the remaining birds perhaps the most interesting is the now extinct New Zealand quail; and so far I have only got the sternum, tibia, and metatarsus. I believe that until a comparatively recent time it must have been plentiful on the open country around the Rocks; but now skins are almost priceless, and I do not know of a skeleton in any collection. Two sterna in the Christchurch Museum were found in Monck's Cave, at Sumner.

List of Birds whose Remains were found in the Fissure at Castle Rocks.

Glaucopis cinerea.
Miro, *sp.*
Anthus novæ-zealandiæ.
Anthornis melanura.
Stringops habroptilus.
Sceloglaux albifacies.
Circus gouldi.
Harpagornis moorei.
Coturnix novæ-zealandiæ.
Carpophaga novæ-zealandiæ.
Notornis (hochstetteri?).
Ocydromus australis.
Ocydromus minor, *n.s.* = sylvestris?
Fulica prisca, *n.s.*
Puffinus, *sp.*
Anas finschi.
Apteryx australis.
Apteryx oweni.
Aptornis defossor.
Anomalopteryx didinus.
" didiformis.

* Ann. de la Soc. Géol. de Belg., vol. ii., p. 123.
† Trans. N.Z. Inst., 1876, art. xciii., p. 599, and pl. xxviii.

Art. XII.—*Notes on Birds.*

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 28th March, 1892.*]

The splendid specimen of the genus *Anas* which I exhibit, and have purchased for the Nelson Museum, was shot by a Mr. Harvey in Happy Valley, near Nelson, and sent by him to Mr. Hale, poulterer and gamedealer, where it excited some degree of curiosity as to its species. My attention was drawn to it, and I expressed an opinion that it was a hybrid; but several old colonists affirmed that it was a distinct species, and had been seen at rare intervals before.

I purchased the bird and had it mounted, and afterwards sent it to Sir Walter Buller for his opinion, who very kindly examined it, and sent me the following written notes upon it:—

"This duck is undoubtedly a hybrid. The head is that of the grey duck (*Anas superciliosa*), although the markings are somewhat indeterminate. The general plumage of the body is a pale slaty-grey, the feathers of the upper parts, however, having pale-brown margins. The wing-feathers and scapulars are of lighter colour, being of a uniform French-grey with dark shaft-lines, but without the dark margins. The median wing-coverts are dull velvety-black, changing to grey, and broadly tipped with white. There is a narrow speculum down the centre, one of the coverts having an exterior border of metallic-green. The smaller wing-coverts display a conspicuous band of white, forming an upper alar bar. The upper tail-coverts are margined with dusky-brown, and the tail-feathers—but very narrowly—with a clearer brown. The whole of the lower fore-neck and the crop have a chestnut-brown hue, each feather, however, being warmly edged with light-grey, which character is more pronounced on the sides of the body and flanks, where the feathers have their webs freckled and vermiculated with grey. The under tail-coverts are darker, and have dull chestnut-brown margins. The bill is blackish-brown, the upper mandible with a black nail and the lower largely marked on its central portions with yellow.

"This bird is either a cross between the grey duck (*Anas superciliosa*) and the blue mountain-duck (*Hymenolæmus malacorhynchus*), or between our domestic duck and the former. The slaty ground-colour and the reddish tinge on the breast and under tail-coverts would favour the former view; but the large size of the bird and the character of the bill and legs would support the latter supposition, which is probably the correct one."

Whatever may be the true solution, the bird is an interesting specimen, and a valuable addition to our Museum.

APTERYX HAASTII.

The specimen of *Apteryx haastii*, or large grey kiwi, was sent to me through the post by Mr. Charles Douglas, from near Okura, in Westland, who desired me to determine to what species it belonged. Mr. Douglas states he found it in a hole under a log, together with a kiwi of the common kind (*Apteryx oweni*), and since, as he states, "he has always before observed that individuals of the two species indulge in a fierce conflict whenever they meet," he concluded this specimen must either be a hybrid or a new species.

The bird was badly preserved, but I sent it on to Sir Walter Buller for inspection, and he identifies it as an immature specimen of *Apteryx haastii*—a rare species, and of which there is not (to his knowledge) any example in the public museums of Europe.

It was first obtained in the high ranges near Okarito, Westland, and when I was there some eleven years ago I frequently heard it spoken of under the name of "roa," but never personally saw one. It would be well to endeavour to obtain a good specimen for our Museum.

ART. XIII.—*On the Occurrence of the Luth, or Leathery Turtle, on the Coasts of New Zealand.*

By T. F. CHEESEMAN, F.L.S.

[*Read before the Auckland Institute, 25th July, 1892.*]

ABOUT the end of May in this year several paragraphs appeared in the local newspapers respecting a marine animal captured off the Bay of Islands by Captain Subritzky, of the schooner "Medora." At first I took the statements to refer to an unusually large specimen of the green turtle (*Chelonia viridis*), a species which is plentiful in many parts of Polynesia, and in tropical seas generally, and which frequently wanders so far from its ordinary habitats as to be seen off the northern coasts of New Zealand. But I was assured that this was not the case; and, as Captain Subritzky brought his specimen to Auckland for exhibition, I took an early opportunity of inspecting it. I had then no difficulty in identifying it with the luth, or leathery turtle (*Sphargis coriacea*), the largest of all living chelonians, and one which has never before been noticed in our seas. As some little interest attaches to the discovery

of animals in localities widely separated from their usual home, I propose to put on record the facts connected with its capture.

Captain Subritzky informs me that on Sunday, the 22nd May, when passing Cape Brett on a voyage from Awanui to Auckland, he noticed a floating object, which he at first took for a boat bottom upwards. The schooner's boat was lowered, and he proceeded to inspect it; when, to his astonishment, it suddenly disappeared, shortly afterwards reappearing a little distance further away. Returning to his vessel, he secured a harpoon and line, and then pulled cautiously up to the creature, soon recognising it to be a large turtle-like animal entirely new to him. After a little manœuvring he succeeded in harpooning it in the neck. According to him, it made a most determined resistance, making for the boat open-mouthed, snapping its jaws violently. It succeeded in getting its flappers over the side of the boat, nearly capsizing it, but was stunned by a blow on the head, towed alongside the schooner, and hoisted on board.

Good descriptions of the luth are given in many well-known books on zoology, so that it is quite unnecessary for me to give any lengthy account of it. I will only say that it differs from all the other sea-turtles in the body not being covered with hard plates, but with a thick leathery skin, which is quite smooth when the animal is adult, with the exception of seven conspicuous longitudinal ridges, but is covered with tubercular scales when very young. As I have already said, it is the largest of living turtles. Specimens over 9ft. in length, and weighing nearly 1,800lb., have been captured. Captain Subritzky's specimen is much smaller, its total length being a little over 6ft., but, from the longitudinal ridges showing a few tubercular projections, it is probably not yet adult. Its measurements are as follow :—

	Ft.	in.
Length of carapace	4	7
Breadth "	2	9½
Depth	1	3
Length of head	0	11½
Breadth "	0	10½
Depth "	0	8½
Diameter of eye	0	1
Diameter of orbit	0	2
Length of anterior paddle	2	11
Width of same (greatest)	0	10½
Length of posterior paddle	1	6
Greatest width of same	0	9½
Total length of animal	6	1
Diameter from tip to tip of the expanded paddles	7	6

The proper home of the luth is in the warmer parts of the Atlantic, Indian, and Pacific Oceans. Its enormous paddles give it great swimming-powers, and it consequently ventures far out to sea, and sometimes strays to very distant localities. Specimens have been stranded on the coasts of France and Holland, and one or two have reached England. In the temperate parts of the Southern Hemisphere it has only once been noticed—in 1862, when a half-grown specimen was captured at Portland, on the coast of Victoria. Probably both that and the one now under consideration have wandered from the Polynesian islands, where it is said to be occasionally seen, but never in large numbers.

Art. XIV.—*On a Specimen of Sunfish captured at Poverty Bay.*

By Archdeacon W. L. Williams.

[*Read before the Auckland Institute, 17th October, 1892.*]

It is now nearly three years since that a large specimen of sunfish (*Orthagoriscus mola*), the dimensions of which are worth recording, was captured by some men who were working on the Gisborne breakwater. After it was safely landed the fish was exhibited by its captors. I had not the good fortune to see it myself; but Dr. A. H. Williams, who saw it, measured it carefully, and found that the length from snout to tail was 9ft. 8in., and that the depth from tip to tip of the fins was 11ft. 6in. It is much to be regretted that so fine a specimen was not preserved in some way and placed in one of our museums.

The following account of the fish, and of its capture, was given me by Mr. W. J. Fox:—

"On the 12th December, 1889, as I was working on the large crane on the breakwater, I observed what I took to be the fin of a large shark appearing above the water about a quarter of a mile east of the breakwater. I at once went, with a companion, in a boat to the spot, taking some dynamite with us; but the creature had disappeared. After a while we discovered it lying on the bottom, on its side, in about 10ft. of water, and I thought it might be a calf whale. We dropped a charge of dynamite down to it, which, when it exploded, must have stunned it, and turned it over. We then returned to the breakwater to fetch a boat-hook. After the explosion of another charge of dynamite the fish came to the surface, and lay with one side of its head out of the water.

We then laid a dynamite cartridge on the head, with a short fuse attached, the explosion of which effectually stunned it. and then we were able to get a rope round it and to tow it to the breakwater. Our rope not being strong enough to lift it by, we used the chain sling and the grab of the 'Hercules.' Judging from the power it required to lift it, the engineer reckoned that the weight must have been about 3½ tons. The length from head to tail was 9ft., and the measurement from tip to tip of the upper and lower fins was 11ft. 6in. When the fish was brought out of the water, the body was found to be covered with small red insects, like what are commonly known as whale-feed. We tried to skin it, but did not succeed, as it seemed impossible to separate the skin from the flesh, which was like a mass of white indiarubber. The eye looked small, only about 2in. in diameter; but when it was opened out it was found to be about the size of a 56lb. shot. As soon as it was dead—about 3 o'clock in the afternoon—a long worm began to come out from the mouth, the end of which had not appeared when the fish was buried two days afterwards.

"WILLIAM J. FOX."

The worm mentioned in Mr. Fox's account as having come out from the mouth is said to have been like a narrow tape, and many yards in length.

ART. XV.—*Further Notes on New Zealand Earthworms, with Observations on the known Aquatic Species.*

By W. W. SMITH.

Communicated by R. M. Laing, B.Sc.

[*Read before the Philosophical Institute of Canterbury, 5th October, 1892.*]

SINCE my last paper on New Zealand earthworms* our knowledge of the group has been greatly augmented by a series of valuable papers by Mr. F. E. Beddard, F.R.S., on the anatomical structure of ten new species. These beautifully-illustrated papers on New Zealand earthworms have appeared during the last five years in several British scientific journals, and, like several anomalous species in other indigenous groups, several of them described are unique among terrestrial *Oligochæta*. In addition to these papers, others have appeared on several unique and remarkable native species belonging to the aquatic group, which have also been described and figured in

* Trans. N.Z. Inst., vol. xix., p. 123.

masterly style by the same able author. As the journals in which Beddard's papers are published are expensive, and, for the most part, inaccessible to general readers in New Zealand, I propose to give an abstract of each paper, embodying the principal anatomical details of each species, and to record some further observations on the habits of both native and introduced terrestrial and aquatic forms.

Since the publication of Darwin's famous treatise on the formation of vegetable mould by earthworms, the habits of this much-neglected group are now receiving the attention of younger naturalists in other countries, and already the literature of the subject is considerable. The breeding habits of worms have not, however, received much attention, and any accurate notes on them made during the breeding-season will be acceptable to naturalists. When living at Lake Brunner, in 1887–88, I devoted considerable time to the habits of worms living in the primeval forest, and since then I have had opportunities of studying them for a year in Victoria, and latterly at Ashburton, New Zealand. The cocoons of earthworms, their time of deposition, and the development of the embryos have interested me much for many years. In recording the facts ascertained by the careful study of worms, I may say that I do so in the hope of stimulating others to the study of these highly beneficial and interesting animals. It may be added that there is every possibility of many new species still remaining to be added to the list, the discovery of which is always a pleasure. In remote, humid islands like those of New Zealand, which have been long separated from any extensive land area, the conditions are more favourable for the preservation of old ancestral forms. We fully realise this fact in many endemic species among the higher groups of animals, and it appears to be further realised in earthworms, as a New Zealand species (*Deinodrilus benhami*) forms the basis of Beddard's genealogical tree of *Acanthodrili*. The genus *Acanthodrilus* is largely represented in New Zealand; and, of the twenty-seven recorded species, seven are from New Zealand. Mr. Beddard has, in addition to these, two or three new species as yet undescribed, and doubtless many more remain to be discovered. The genus *Perichæta* will, I believe, also prove to be well represented in the number of species, as the natural conditions are very favourable to their habits. The three endemic species of aquatic *Oligochæta* described by Beddard represent separate genera, and they are sufficiently interesting to students of the group. A number of introduced terrestrial and aquatic species occur in many districts in New Zealand: these will presently be noticed separately.

In his remarks on the habits of earthworms, and the occurrence of their castings in forests, Darwin stated that, "In

Venezuela, castings, probably ejected by a species of *Urochæta*, are common in the gardens and fields, but not in the forests, as I hear from Dr. Ernst, of Caracas."* In the forests of Westland I was unsuccessful in finding a single casting, except where the bush had been cleared, and trodden by cattle. In the more remote untrodden bush the roots of ferns and mosses, of seedling and sapling trees and shrubs, form a dense network of considerable depth, in which worms do not appear to exist. We found them occasionally under fallen and decayed logs, and they are exceedingly numerous in the dark-coloured subsoil underlying the *débris* and roots of the forest. The subsoil in many parts is extremely rich, and doubtless formed the original surface mould of the country before the now magnificent forest spread over it. The small bush-clearings made by settlers are soon compressed by cattle, and in a few years the castings of earthworms are ejected plentifully on the surface. In the valley of the Grey River the older bush-clearings produce a rich growth of English grasses, and worms are plentiful in the soil. Where well-trodden paths or land exist their castings abound in great numbers. When digging for specimens we observed the varying depths of the superficial mould overlying the original layer of forest *débris*. Some of the clearings are twenty and twenty-five years cleared, and several of the sections we examined showed distinct layers of surface-soil, varying from 7in. to 11in. in depth. The original layer of forest mould was distinctly traceable, which also varied considerably in depth. This rate of accumulation of mould is greater than any results given by Darwin, at least during the period of time it accumulated. If, however, we consider the extremely humid and mild climate of Westland generally at all seasons of the year, the result is perfectly reconcilable. Darwin's researches on the accumulation of mould by earthworms were carried on in England, which country cannot compare with the mild and humid climate of Westland, at least in the natural conditions favourable for the actions and increase of worms.

The introduction, great increase, and rapid dispersion of alien forms may be briefly discussed here. No doubt the several species of British and other exotic worms now common in New Zealand have been introduced at various times in the soil of plant-cases, and in the soil used as ships' ballast. The phenomenal increase of aliens is due chiefly to the genial climate, and to the absence of their natural enemies. The rich land in many parts of the country is also very favourable to their increase. The rapid dispersion of introduced worms is due to the distribution of trees and shrubs from nurseries,

* "Vegetable Mould," p. 123.

and to the extensive system of planting English trees in nearly all parts of the country, which has proceeded for many

The habits of British earthworms are so well known to naturalists that, as they cannot differ materially in New Zealand, little need be said about them. I may, however, mention a few items which are of interest. The prodigious destruction of earthworms during heavy rains and floods must check their increase considerably. Nevertheless they exist in some gardens in immense numbers. During the heavy rains in August last I observed several lawns and pieces of garden absolutely covered with a dense layer of castings. At the same time the destruction of worms was phenomenal. After a heavy night's rain, a slight frost occurred for several mornings at daybreak, and destroyed the worms crawling about the streets and footpaths in myriads. The street channels also convey vast numbers to the rivers, by which they are borne to the sea and thus perish.

The breeding habits of worms are not well known to naturalists: yet such is an important line of research. The cocoons are easily found in the habitats of worms, and are deposited in moist chambers excavated a little distance from the walls of their burrows, but never in the burrows they inhabit. They may be found throughout the year, but they are more numerous during winter and spring. Although I have carefully examined hundreds of adult worms annually for several years, I have never observed one in the act of fabricating a cocoon: I have, however, found the latter in all stages of development, ranging from the newly-deposited to mature cocoons with the young worms in the act of escaping from them. The cocoons of *Acanthodrilus multiporus* when newly deposited are dull-white in colour, and are very smooth and flaccid. They are filled with a white albuminous fluid which nourishes the embryo. The cocoons vary considerably in colour, according to their age and the stage of development of the embryos within them. From white they pass through several shades of yellow and brown to dark-red, which latter colour indicates maturation of the embryos. When the young worms emerge from the cocoons they are semi-transparent and delicate. The circulatory system is clearly visible for a few days, or until the integument thickens and assumes the uniform pale-pink colour of the young of this species. We have kept many cocoons of several species of indigenous worms, and observed the young emerging. The cocoon is composed of several layers of an extremely tough semi-transparent material, and as the embryo matures and presses upon the inner walls of the cocoon each layer generally yields in succession until the last opens, when the young worm slowly

emerges. The cocoon generally bursts longitudinally, and we have observed the inner mucous coating of the cocoon to be slightly tinged with blood after the worm had escaped. The time occupied, and the position of the young worm's body while emerging, varies according to the texture of the cocoon: some yield freely and allow the young worms to escape in a few hours without difficulty; others are stronger in texture, causing the time of emergence to be more prolonged. I cannot state accurately the time required for the full development of the embryos, as it must vary according to the conditions of the soil and temperature surrounding them. Judging by the colours of the cocoons changing as the embryos developed within them, and allowing that the cocoons may have been several days or weeks old when dug out of the soil, we found the worms to emerge at periods varying from eighty to a hundred and forty-two days. We endeavoured to ascertain the time of development by peeling off several of the thin outer layers of the cocoons, and holding them close to a bright lamp at night, and studying them with a strong lens. Although this method is not quite satisfactory, it nevertheless affords a fairly accurate means of ascertaining the approximate time required for the development and emergence of the embryos. I do not possess a copy of Beddard's paper on the anatomy of *Acanthodrilus multiporus*, *A. novæ-zealandiæ*, *A. dissimilis*, and another species or variety sent to him by Professor Parker, F.R.S., from the neighbourhood of Dunedin; but the following abstract of a paper* on the development of *A. multiporus* presented by Beddard to the Royal Society two years ago will afford some idea of the interesting worm:—

"In the young embryos of this worm each segment is furnished with a pair of nephridia, each opening by a ciliated funnel into the segment in front of that which carries the dorsally-placed external pore. In later stages the funnels degenerate, and that portion of the tube which immediately follows the funnel becomes solid, losing its lumen; at the same time the nephridium branches, and communicates with the exterior by numerous pores. At a comparatively early stage, four pairs of gonads are developed in segments x.–xiii.; each of these is situated on the posterior wall of its segment, as in *Acanthodrilus annectens*, and not on the anterior wall as in the majority of earthworms. When the gonads first appear, the nephridial funnels, with which they are in close contact, are still ciliated, and their lumen is prolonged into the nephridium for a short distance. Later the cilia are lost, and the funnels increase greatly in size, while those of the neighbouring segments—in fact, all the remaining funnels—remain stationary

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* N.Z. Journal of Science, vol. i. (new issue), p. 72.

for a time, and then become more and more degenerate. The large funnels of the genital segments become the funnels of the vasa deferentia and oviducts. It will be observed that the number of ovaries and oviducal funnels (two pairs) at first corresponds to that of the testes and sperm-duct funnels; subsequently the gonads and commencing oviducts of segment xii. atrophy. Each of these large funnels is continued into a solid rod, which passes back through the septum, and then becomes continuous with a coiled tuft of tubules, in which there is an evident lumen, and which is a part of the nephridium of its segment. In the segments in front of and behind the genital segments the rudimentary funnels communicate in the same way with a solid rod of cells, which runs straight for a short distance, and then becomes coiled and twisted upon itself, and provided with a distinct lumen. In fact, apart from the relative size of the funnels and the presence of the gonads, it would be impossible to state from which segment a given section through the terminal portion of a nephridium had been taken. In a later stage the large funnels of the genital segments become ciliated, but this ciliation takes place before there is any marked change in the tube which is connected with the funnel.

"In the young worm which has just escaped from the cocoon the funnels are ciliated, and they are each of them connected by a short tube, in which a lumen has been developed, but which ends blindly in close proximity to a coil of nephridia. No trace of any nephridial tube other than the sperm-duct or oviduct could be observed, whereas in the preceding and succeeding segments the rudimentary nephridial funnel, and a straight tube leading direct to it from the body-wall, were perfectly plain. Dr. Bergh has figured, in his account of the development of the generative organs of *Lumbricus*, a nephridial funnel in close contact with the funnel of the genital duct. It may be suggested that a corresponding funnel has been overlooked in the embryo *Acanthodrilus:* the continuity of a structure, identical (at first) with the nephridia of the segments in front and behind, with the genital funnels, seems to show that a search for a small nephridial funnel would be fruitless.

"I can only explain these facts by the supposition that in *Acanthodrilus multiporus* the genital funnels and a portion at least of the ducts are formed out of nephridia. This mode of development is a confirmation, to me unexpected, of Balfour's suggestion that in the *Oligochæta* the nephridium is broken up into a genital and an excretory portion.

"In the comparison of the facts briefly described here with the apparently-independent origin of the generative ducts in other *Oligochæta*, it must be borne in mind that in *Acantho-*

drilus the segregation of the nephridium into several almost detached tracts communicating with the exterior by their own ducts precedes the formation of the genital ducts."

Introduced Worms.—I here append a list of exotic species which we have collected in several localities in the South Island. They have been identified for me by Mr. Beddard and Mr. J. J. Fletcher, F.L.S., the author of several valuable papers on Australian earthworms.*

Microscoles modestus, Rosa (*Endrilus* (?) *dubius*, Fletcher).
Allolobophora rubicunda, Eisen. (*Lumbricus campestris*, Hutton).
" *fœtidus*, Sav. (*Lumbricus annulatus*, Hutton).
" *turgidus*, Sav.
" *purpureus.*
" *rubellus*, Sav.
Lumbricus terrestris.
Allurus tetraedrus, Sav.
Tubifex rivulorum.

The first-named species is one of wide distribution; it occurs in Australia, Tasmania, Norfolk Island, and New Zealand. It was first described by Dr. Rosa, who obtained a single specimen among some soil which had been brought to Genoa with plants from Buenos Ayres. Four months later it was described by Mr. Fletcher as *Endrilus* (?) *dubius*, which name must now be regarded as a synonym. There still, however, exists some doubt as to there being one or two species—a larger and a smaller form. Both forms are common in gardens at Ashburton, the smaller one inhabiting garden-soil, the larger form occurring in rubbish-heaps and old heaps of manure. Fletcher gives its measurements at 45mm. to 65mm. long, with a "clitellum of a yellow hue." The clitellum of the smaller form occurring at Ashburton is reddish in colour, that of the larger one is distinctly yellow, while some specimens attain a length of 4in. and 4½in. It is a robust species, and easily identified by its yellow posterior extremity.

The second and third species in the above list were described† by Professor Hutton; his names, however, must now remain as synonyms. *Allolobophora turgidus* is another remarkable species, having a wide geographical range. It occurs in North America and Mexico, in many parts of Australia, Tasmania, and New Zealand. It is rapidly spreading and increasing everywhere where gardens are cultivated. *Allolobophora purpureus* is common in some districts in gardens, and *A. rubellus* occurs in moist soil on swampy flats,

* Proceedings of the Linnean Society of New South Wales, vols. i. and ii. (Second Series).

† Trans. N.Z. Inst., vol. xii., p. 277.

and under moist cakes of cow-manure. *Lumbricus terrestris*, Linn., is common everywhere, and the curious species *Allurus tetraedrus* occurs in the stiller pools of the Ashburton River and in the moist sand along their banks. The aquatic *Tubifex rivulorum* also occurs in millions on the bottom of shallow, slow-flowing streams, their red colour resembling large masses of coagulated blood. The habits of this aquatic annelid are thus described by Beddard: "It lives associated in great numbers, and partially imbedded in mud at the bottom of streams, &c.; the head-end is fixed in the mud, while the tail waves freely about in the water. These worms form exceedingly conspicuous red patches, which must attract ground-feeding fish. The colour is due to a substance termed hæmoglobin dissolved in the blood. This substance is also found in the blood of the higher animals, and it plays the chief part in respiration; it is able to absorb from the air, and readily give up to the tissues, oxygen." *

Referring briefly to the occurrence of cocoons of introduced earthworms, I may mention a few items of interest regarding them which I have ascertained. The cocoons of native worms living in solid ground are invariably deposited in moist chambers at distances varying from ¼in. to 1½in. from the walls of their burrows. In gardens where exotic worms are generally abundant the cocoons are deposited promiscuously in the loose soil. They occur at various depths, and frequently, in moist weather, they lie within an inch of the surface. Such species as *Allolobophora fœtidus*, *A. rubicunda*, *A. turgidus*, will deposit their cocoons under flat stones, slabs of wood, or old bags lying on the surface of the soil. If the bags be spread out and slightly covered with some soil or litter, and kept moist, it is a simple matter to procure cocoons from the month of August to December.

The formation of the cocoon-chambers of indigenous worms is not effected at any particular part of their burrows: they are formed at all parts of the latter, from the bottom turn to within 1½in. of the surface. I have found as many as three cocoons of various ages attached to one burrow, and two occur commonly. These remarks apply only to the burrows of the various species of *Acanthodrilus* which I have examined. I, however, found two cocoons in the burrows of *Perichæta dorsalis*, Fl., an Australian species. The chambers are doubtless formed by the worms swallowing the soil while excavating them. Their interior is smooth, and the short channels leading to them are tightly packed with voided earth.

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* "Animal Coloration," p. 6 (1892).

Genus DEINODRILUS, Beddard.

Deinodrilus benhami, Beddard. Quart. Jour. Mic. Sci., vol. xxix.

This remarkable species, which forms an intermediate link between *Perichæta* and *Acanthodrilus*, was discovered in November, 1887, in the forest mould at Lake Brunner, Westland. I cannot, however, give any account of its habits, as the specimens were collected, along with others of *Perichæta intermedia*, only a few days before I left the district. Its structural characters are defined by Beddard as follows:—

"This remarkable genus can be at once distinguished from any other by the fact that the setæ, though paired, are more than eight in number to each segment. All the segments of the body are furnished with six pairs of setæ, three on each side, arranged at about equidistant intervals. The arrangement of the setæ, therefore, in *Deinodrilus* offers an intermediate condition between the four pairs of *Lumbricus*, &c., and the continuous row of numerous setæ of *Perichæta*, which has been hitherto wanting. It is interesting to find that this worm is intermediate between *Perichæta* and *Acanthodrilus* in other characters which will be referred to in the course of the description, and are summed up in the table which concludes the description.

"*External Characters.*—The length of the largest specimen is about 5in. A prostomium is present, but does not completely divide the circumoval segment. The clitellum is well developed in one of the two specimens which I examined; it occupies segments xiv., xv., and xvi., having therefore precisely the range which characterizes so many species of *Perichæta*: as in that genus, the glandular modification of the epidermis of the clitellar segments is continuous right round the body, being equally well developed upon the ventral and upon the dorsal surface. The only apertures visible upon the outside of the body are the dorsal pores, the apertures of the male and female reproductive ducts, and of the spermathecæ. No nephridiopores could be made out. The dorsal pores commence between the eleventh and twelfth segments. The oviducal pores are upon the fourteenth segment; they are paired, and situated a little in front and to the inside of the ventralmost seta. The apertures of the atria are, as in *Acanthodrilus*, two pairs; one pair are upon the seventeenth, the other upon the nineteenth segment; they correspond in position to the outer seta of the ventral pair. The spermathecal pores are close to the anterior body of segments viii. and ix.; they correspond in their relation to the setæ with the male pores.

"*Internal Anatomy.*—The longitudinal muscles have their fibres arranged in that remarkable bipennate fashion which is

found in many species of *Lumbricus* and *Allolobophora*, but is comparatively rare elsewhere. With regard to the vascular system, the only facts which I am able to record are—(1) the condition of the dorsal vessel; (2) the number and connection of the 'hearts.' The dorsal vessel is a completely-double tube, with the exception of that portion which lies in the first four or five segments. It resembles the dorsal vessel of *Acanthodrilus multiporus* in the fact that the tubes are perfectly separate throughout, except where they become permanently fused at the anterior extremity of the body. The somewhat contracted condition of the worm frequently caused the two halves of the dorsal vessel to become widely separate in the middle of each segment, while at the mesenteries they come into close relation: there is, however, no fusion of the two tubes at these points, such as occurs in *A. novæ-zealandiæ* and *Microchæta*. I observed six pairs of lateral 'hearts,' the last pair being in segment xiii.; the last four pairs are specially large, and are connected with the supra-intestinal as well as with the dorsal vessels. The anterior two pairs (there are probably one or two pairs in addition to those I have mentioned) are much more slender, and only connected above with the dorsal vessel.

"*Septa.*—The septa separating segments viii.–ix., ix.–x., x.–xi., xi.–xii., xii.–xiii., are thicker than the rest, but not to so marked a degree as is often met with in earthworms.

"*Alimentary Tube.*—The pharynx has the usual characters. The gizzard lies in segments vi. and vii.; the œsophagus is thick-walled and highly vascular, but there appeared to be no distinct calciferous glands. The intestine has a typhlosole. The nephridia are not obvious on dissection except in segments ii., iii., and iv.; in each of these segments is a tuft of nephridial tubules of considerable size; in the posterior segments nephridia are present, and open on to the exterior by several pores in each segment. The nephridial system of this worm is in fact like that of *Acanthodrilus multiporus*.

"In *Deinodrilus* the dorsal blood-vessel is surrounded by a special cœlomic space in a way that is, at present, unique among earthworms. This space does not appear to exist in the first fifteen segments; after this point the two dorsal blood-vessels are not as plainly visible on a dissection of the worm as they are anteriorly; the red colour of the blood is masked by the whitish colour of the tissues which form the walls of the perihæmal space. The fact that the blood-vessels are so clearly seen on dissection in the anterior segment leads me to infer that here there is no perihæmal cœlomic space; but I am unable to support this view by the microscopical appearance of the dorsal vessels in this region of the body, which I have not investigated by sections. The enclosure

of the dorsal blood-vessel in a special cœlomic sac suggests, of course, the pericardium of higher types, and in any case it may be compared with the condition of the cœlom in the *Hirudinea*, where the principal blood-vessels as well as other organs are often included in separate cœlomic spaces. Among the *Chætopoda* also a commencement of a secondary subdivision of the cœlom is to be seen. In the *Capitellidæ* a series of longitudinal chambers enclose the nephridia and other organs, but I am not aware that hitherto anything of the kind has been described in the *Oligochæta*.

"*Reproductive Organs.*—The *vesiculæ seminales* occupy segments xi. and xii.; they are racemose organs like those of *Acanthodrilus*. The testes I have not seen. The *vasa deferentia* open by funnels in segments x. and xi.; the funnels of segment xi. are quite independent of the *vesicula*. I could not trace the course of the vasa deferentia, but in all probability they open, as in *Acanthodrilus*, upon the eighteenth segment. The *atria* are in segments xvii. and xix. The external apertures of these organs have been already mentioned. The atria themselves are so exactly like those of *Acanthodrilus* that no further description is necessary. The *ovaries* are situated on the anterior wall of segment xiii.; they are digitate bodies like those of *Acanthodrilus*. The *oviducts* open by funnels, which are placed near to each other, and on either side of the nerve-cord, on the posterior wall of segment xiii. The external pores are upon the fourteenth segment. The *spermatheca* has a very characteristic form. . . . The spermatheca is a somewhat oval pouch, which suddenly narrows into a slender duct, opening close to the anterior margin of the segment. At the junction of the pouch with the duct are three diverticula, two on one side and one on the other. The diverticula are very much smaller than the pouch, and of a regular oval form.

"The following table indicates the principal points in which *Deinodrilus* agrees with *Acanthodrilus* or *Perichæta*:—

	Acanthodrilus.	Deinodrilus.	Perichæta.
Clitellum	Segments xii.–xix., or thereabouts, undeveloped between the atrial pores and the corresponding area on the other segments	Segments xiv.–xvi. (inclusive) continuous all round the body	Usually segments xiv.–xvi. (inclusive) continuous all round the body.
Setæ ..	8 per segment ..	12 per segment ..	20–100 per segment.
Atria ..	Two pairs of convoluted tubes opening on to segments xvii. and xix.	Two pairs of convoluted tubes opening on to segments xvii. and xix.	Usually represented by a single pair of branched glands opening on to the eighteenth segment

"In Bourn's *P. stuarti* the atria appear to be like those of *Acanthodrilus*.—F. E. B."

Genus Acanthodrilus.

Acanthodrilus annectens, Beddard. Quart. Jour. Mic. Sci., vol. xxix.

In rich unbroken land, and in moist earth near water-courses and swamps, this species is generally common. It is readily distinguished from all other *Acanthodrili* by its variegated colours of white and pink. In habits it is sluggish, and secretes a whitish fluid when handled or otherwise removed from the burrows. The species vary much in size, the larger forms occurring in rich black mould on the moist edges of swamps. Its specific structural characters are thus defined by Beddard:—

"This species combines to a certain degree the characters of two other New Zealand *Acanthodrili* recently described by me—viz., *A. multiporus* and *A. novæ-zealandiæ;* not, however, to so marked an extent as might lead one to infer the possibility of its being a hybrid. It is a comparatively small worm, measuring about 3in. in length.*

"*External Characters.*—The setæ are paired, the individual setæ being at some little distance from each other. The *clitellum* occupies segments xiii.–xx. (inclusive); the glandular modification of the epidermis is not developed on the ventral surface, as is usual in this genus. The anterior end of the body is somewhat swollen, and the segments here are somewhat difficult to map owing to the division of the segments into numerous annuli. In these particulars the present species agrees very closely with *A. multiporus*. The *atrial pores* are upon the seventeenth and nineteenth segments, and correspond in position to the outermost of the ventral pair of setæ. They are placed upon the summits of prominent papillæ; the two pores of each side are connected by a groove. In one specimen the pore of the *vasa deferentia* was visible upon the eighteenth segment. As a rule these pores are invisible. The *oviducal pores* are paired, and lie upon the fourteenth segment; each is placed in front of, and a little to the inside of, the ventralmost seta of the ventral pair. The *spermathecal pores* are in the furrows separating segments vii.–viii. and viii.–ix.; they correspond in position to the atrial pores. The *nephridiopores* are visible in most of the segments of the body; they lie in front of the outermost seta of the outer pair.

"*Internal Anatomy.*—The most remarkable fact about the

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* I have lately collected well-developed specimens, with a yellowish clitellum, measuring 4in. and 4½in. in length.—W. W. S.

reproductive organs of this species is, that the testes and ovaries, instead of being situated on the anterior wall of their respective segments, are placed upon the posterior wall in close proximity to the funnels. I should have been disposed to regard this arrangement as abnormal had it not been for the fact that it occurred in all of the two or three specimens studied by me. The *vesiculæ seminales* of this species are like those of other *Acanthodrili* in their racemose character, and in the fact that they do not envelope the funnels of the vasa deferentia. It may easily be seen in longitudinal sections of the worm that the vesiculæ, although so different in outward appearance from those of *Lumbricus*, only differ in being branched instead of simple outgrowths of the septa. The *atria*, as is always the case with *Acanthodrilus*, are two pairs situated in the seventeenth and nineteenth segments. The vasa deferentia, as also appears to be the rule in this genus, open quite independently of the atria upon the eighteenth segment. The two vasa deferentia unite just before their external orifice (♂), which is situated just on the boundary-line between the seventeenth and eighteenth segments; the pores are also situated in a groove which connects the two atrial pores of each side, and the presence of which is highly characteristic of the genus *Acanthodrilus*, as also of *Deinodrilus*. The two vasa deferentia run side by side, and obliquely, through the muscular layers of the integument to the external pores, crossing on their way the duct of the atrium of the seventeenth segment. In longitudinal sections I traced the vasa deferentia back to the thirteenth segment, running in the longitudinal muscular layer, and at some distance from the surface, nearly midway between the two surfaces of the longitudinal muscular layer; after this they gradually approach the peritoneal face of the muscular layer, and for the last portion of their course were imbedded in the peritoneum. I am not aware that in any other earthworm the vasa deferentia are known to run deep within the longitudinal muscular layer. As in *A. multiporus*, there appear to be no penial setæ. The *ovaries* are upon the posterior septum of the thirteenth segment, and are actually in contact with the funnel of the oviduct. The oviducts traverse the septum which separates segments xiii. and xiv.; the funnels are in the thirteenth segment. The *spermathecæ* are present to the number of two pairs, and are situated in segments viii. and ix. They are elongated narrow pouches, and each is furnished with two pairs of minute diverticula.

"*Vascular System.*—The dorsal vessel is double throughout, as in *A. multiporus*; the transverse hearts are especially conspicuous in the tenth, eleventh, twelfth, and thirteenth segments; the vascular trunks are, indeed, indistinguishable from those of *A. multiporus*, with which species the present

has several other points in common. It will be remembered that *A. novæ-zealandiæ* differs from the present species and *A. multiporus* in the fact that the two dorsal vessels are united where they perforate the intersegmental septa.

"*Nephridia.*—The third and fourth segments of the body are occupied by a conspicuous mass of nephridial tubules, which had a pinkish colour in the specimens dissected. This evidently corresponds to the 'mucus-gland' found in the other New Zealand species, *A. multiporus*. The nephridia throughout the rest of the body are regularly arranged, one pair to each segment; the apertures do not alternate in position, but are invariably placed in the neighbourhood of the lateral pair of setæ. There is no conspicuous muscular sac forming the extremity of the tube, as in nearly all the other species of the genus. The nephridia therefore are, on the whole, more like those of *A. novæ-zealandiæ* than of *A. multiporus*.

"*Alimentary Tract.*—The pharynx commences in the second segment, and extends back as far as the end of the fourth. The gizzard occupies the fifth segment. Its proper position can only be satisfactorily made out by longitudinal sections, which show that the septum dividing segments v. and vi. is attached to the posterior extremity of the gizzard: as, however, the next septum is attached quite close to the former, the growth of the gizzard has brought about an increase in the capacity of that section of the body-cavity belonging to the fifth segment, at the expense of segment vi. *Calciferous glands* were entirely absent, but the œsophagus was extremely vascular. The *intestine* is furnished with a typhlosole which resembles that of *Deinodrilus*. This structure—the typhlosole—has a characteristic form in, at any rate, three species of *Acanthodrilus;* in the present species it is a simple fold, projecting through about one-third of the lumen of the intestine. In *A. multiporus* it has about the same relative proportions, but is trifid at the extremity. In *A. dissimilis* the typhlosole has shrunk to the most insignificant dimensions."

In the summary of his paper Mr. Beddard mentions the following most important facts described therein: "(1.) The independence of the vasa deferentia and atria in *Acanthodrilus;* the two vasa deferentia of each side unite just before their opening on the eighteenth segment. The atria (='prostates') open separately upon the seventeenth and nineteenth segments. (2.) The occurrence of six pairs of setæ in each (setigerous) somite of *Deinodrilus*. (3.) The completely double dorsal blood-vessel of *Acanthodrilus annectens* and of *Deinodrilus benhami*. (4.) The enclosure of each half of the dorsal vessel of *Deinodrilus* in a separate cœlomic space."

Acanthodrilus rosæ, Beddard. Quart. Jour. Mic. Sci., vol. xxx.

This species is not uncommon in the Ashburton district. In habits it is similar to *A. novæ-zealandiæ* in being more active than *annectens*, *antarcticus*, *dissimilis*, or *multiporus*, and it is clearly distinguishable from any of these species by its rich-brown colour. In fully-matured individuals the clitellum is well marked, and yellowish-white in colour. Like *A. novæ-zealandiæ* the species is able to secrete, and lubricate its body with, a clear slimy fluid, which probably acts as a distasteful deterrent to its enemies, and also to enable it to penetrate more easily into the soil. The slimy secretions of both species are scentless and almost tasteless, although I may say that I have experienced a very slight tendency to acridity in the fresh secretion of *A. novæ-zealandiæ*. The specific characters of *A. rosæ* are here given, as defined by Beddard:—

"While *A. antarcticus* might easily be confused, on a superficial view, with *A. multiporus*, the present species is by no means unlike *A. novæ-zealandiæ* or *A. dissimilis*. Indeed, the external characters of the spirit-preserved specimens hardly permit the species to be distinguished from one or other of the above-named; but the internal characters enable *A. rosæ* to be recognised as a perfectly distinct and well-marked species; there is no possibility of confounding it with either *A. novæ-zealandiæ* or *A. dissimilis*. The largest specimen measured about 8in. in length. The colour of the spirit-preserved specimen is a rich-brown, darker upon the clitellar segment, and paler ventrally. The *prostomium* completely divides the peristomial segment. The setæ are paired; the pairs are, at any rate in the posterior region of the body, equidistant; this region of the body is quadrangular in section, the setæ occupying the four angles. The *clitellum* occupies segments xiv.–xix. (inclusive), as in *A. novæ-zealandiæ*. The position of the *atrial pores* calls for no special remark, as they are identical in position and appearance with those of *A. novæ-zealandiæ*.

"With regard to the internal anatomy, there are two principal points of difference from *A. novæ-zealandiæ*: firstly, the entire absence of specially-thickened septa. I have dissected a tolerably large specimen, and compared it with a specimen of *A. novæ-zealandiæ* of about the same size; there was a very marked discrepancy in the relative thickness of some of the anterior septa; and this difference could not possibly be accounted for by the unequal size of the two individuals. The second anatomical difference between *A. rosæ* and *A. novæ-zealandiæ* is in the form of the spermathecæ, which, as is

so common among earthworms, have the most varied relations to the septa of the segments containing them, though the situation of the external aperture does not vary at all. Each spermatheca consists of a large pouch with relatively thin walls; this communicates with the exterior by a short thick-walled muscular duct; this duct gives rise to a diverticulum, which terminates in an enlarged cæcal extremity, the surface of which is furrowed. The difference between the spermathecæ of this species and those of *A. novæ-zealandiæ* is that in the latter the diverticula are sessile.

"In *A. rosæ* the structure of the spermathecæ is quite the same as in *A. dissimilis*: in both these worms the epithelium of the diverticulum does not appear to be—originally—so different from that of the pouch, though it comes ultimately to present a strikingly different appearance. The pouch itself is lined with tall columnar cells; in the interior of these are formed spherical masses of secreted granules which seem to closely resemble similar products described by Goehlich in the spermathecæ of *Lumbricus*. The epithelium lining the pouch is slightly folded. The diverticulum of *A. rosæ* is, as I have already stated, composed of a relatively long tube with muscular walls, which terminate in a swollen, somewhat lobate, çæcal extremity; this latter has a structure quite like that of the diverticulum of *A. dissimilis* and of *Neodrilus*. The epithelium is much folded, so as to divide the cavity of the diverticulum; in places the columnar character of the cells can be recognised, but for the most part they are not clearly recognisable, for the reason that they have become largely converted into balls of a viscous-looking substance which does not stain. So far as I have been able to follow the formation of the colloid-looking masses, I am inclined to think that they are the product of a fusion between smaller droplets which appear in the interior of the cells. The secretion, when formed, does not seem to be evacuated into the interior of the numerous cæcal pouches which constitute the extremity of the diverticulum, as it is in the spermatheca itself, but to remain where it was formed. In nearly all the viscous drops were imbedded bundles of spermatozoa, which were always very distinct in my preparations, owing to the fact that they were deeply stained by the colouring reagents used (alum carmine and borax carmine). A superficial examination of such a section almost conveyed the idea that the spermatozoa were developed in the diverticulum, so close is their relation to the epithelium. There can be little doubt, however, that the function of these masses formed by the breaking-down of the epithelium is to retain the spermatozoa within the pouch until ready for transference to another individual. The spermatopores of *Acanthodrilus* are not known,

and we have no information whatever with regard to the process of fecundation in that genus. It seems likely on *a priori* grounds that they will prove to be different from those of *Lumbricus*, owing to the far greater complication of glandular appendages connected with the reproductive ducts."

Acanthodrilus antarcticus, Beddard. Quart. Jour. Mic. Sci., vol. xxx.

In habits and colour this species closely resembles *A. multiporus*. Its smaller size distinguishes it from the larger form, and it is not so common. I find it inhabiting the edge of an old swamp on the south bank of the Ashburton River, and I have also collected a few specimens in other localities. The anatomy of the species is given in the following abstract of Beddard's valuable paper on "New Species of New Zealand Earthworms":—

"The *setæ* are disposed in four series of pairs, but the two setæ of each pair are not close together as in *A. novæ-zealandiæ*. Setæ 1 and 2 are closer together than 3 and 4; the distance between 2 and 3 is about equal to that between 3 and 4. The *prostomium* does not completely divide the first segment; it does in *A. novæ-zealandiæ*. The first *dorsal pore* is between segments v. and vi.; they are not visible upon the clitellum. The *clitellum*, which is distiguishable even in the spirit-specimen by its darker colour, occupies segments xiii. to xvii. The *atrial pores* are, as usual, situated upon the seventeenth and nineteenth segments on prominent papillæ. A longitudinal groove, as in other species, connects the two orifices of each side. The external characters ally this species rather with *A. multiporus* than with *A. novæ-zealandiæ* or *A. dissimilis*; the distribution of the setæ and the characters of the prostomium are much the same: it differs in the less extent of the clitellum, and in the fact that the papillæ upon which the atrial pores are borne are not so prominent as in *A. multiporus*; the prominent atrial papillæ are specially characteristic of *A. multiporus* and also of *A. annectens*. The internal anatomy of *A. antarcticus* shows numerous points of resemblance to *A. multiporus*, though there is no doubt as to its distinctness.

"*Alimentary Tract.*—The pharynx occupies the first four segments; there is a well-developed gizzard in segments vi. and vii.; in the fourteenth and fifteenth segments the walls of the œsophagus probably represent the calciferous glands of other earthworms; in *A. multiporus* these glands are found further back, in the seventeenth segment. I have studied the structure of these glands by transverse and longitudinal sections. It appears that they really represent two pairs of glands such as are found, for example, in *A. dissimilis*, but their apertures into the œsophagus are so large that the glands

present the appearance of being little more than glandular dilatations of the œsophagus itself; in transverse sections, however, the epithelium of the œsophagus can be here and there detected, and it is totally different from the epithelium of the glands; the cells are much more elongated, and are more deeply stained than the cells of the glands by the reagent used (alum carmine); both the glandular cells and the epithelial lining of the œsophagus are furnished with long cilia—a character which distinguishes the calciferous glands of this species from those of *A. dissimilis*, and from certain glands of other earthworms (*e.g.*, *Urochæta*) which have been regarded as the homologues of the calciferous glands.

"*Vascular System.*—The dorsal vessel is like that of *A. multiporus;* it is completely double from end to end of the body; for the most part the two vessels are placed side by side, but they do not fuse at the points where they traverse the mesenteries; on the gizzard the two dorsal vessels come to be somewhat widely separated. The transverse vessels uniting the dorsal with the ventral vessel form large conspicuously-dilated 'hearts' in segments x.–xiii. (inclusive). In all the points *A. antarcticus* agrees closely with both *A. multiporus* and *A. annectens*.

"*Septa.*—The characters of the intersegmental septa appear to offer useful specific characters in this genus; in some species a certain number of the anterior septa are greatly thickened; the number of septa which are thus enlarged, and the degree in which their thickness is increased, differ, for instance, in the present species and in *A. multiporus*. In *A. antarcticus* the septa separating segments vii.–viii., viii.–ix., ix.–x., x.–xi., xi.–xii., are specially thickened, particularly the last four. In *A. multiporus* the same septa, with the addition of one in front and one behind, are thickened, but not so much as in *A. antarcticus*.

"*Genital Organs.*—The testes are two pairs of minute bodies in segments x. and xi.; each is attached to the anterior septum of its segment close to the junction of the septum with the body-wall; it is placed exactly opposite to the funnel of the vas deferens. The *ovaries* occupy a corresponding position in segment xiii., the funnel of the oviduct having a relation to them similar to that of the funnel of the vas deferens to the testis. The two pairs of *atria* are situated in the seventeenth and nineteenth segments respectively; each is a much-coiled glandular tube communicating with the exterior by means of a narrower tube with thick muscular walls. The structure of these organs presents, in fact, no differences from other species. *Penial setæ* are present on both the seventeenth and nineteenth segments, as in most other species of *Acanthodrilus*, but not in *A. multiporus;* the mature penial

setæ are of a deeper yellow colour than the immature ones. The *seminal sacs* are two pairs attached to the anterior wall of segments xi. and xii.; they have the racemose character which is usually seen in this genus. Besides these there are a pair of solid bodies with an oval contour attached to the posterior wall of segments xi. and xii. A microscopic examination of these showed that they are also seminal sacs; groups of developing seminal cells were contained in the spaces of the meshwork, formed of fibroid tissue; there were also numerous gregarines, the presence of which is so characteristic of the seminal sacs of earthworms. There are thus four pairs of seminal sacs, of which the anterior two are outgrowths forward of the septa separating segments ix.–x. and x.–xi; the posterior two are backwardly-directed outgrowths of septa x.–xi., xi.–xii. This arrangement agrees with that of the seminal sacs of *Allolobophora fœtida;* there appears to be no median unpaired sac developed such as is found in *Lumbricus*, *Microchæta*, and even in certain species of *Acanthodrilus*. It is more usual in this genus to find only two pairs of seminal sacs developed, those of the eleventh and twelfth segments, and these usually differ from the anterior pairs in their racemose character; but there are some indications that the real number of these organs is four pairs, possibly in all the species of the genus. The *spermathecæ* are two pairs situated in segments viii. and ix.; each is furnished with a number of small diverticula."

Genus PERICHÆTA.

Perichæta intermedia, Beddard. Quart. Jour. Mic. Sci., vol. xxx.

Like other species of the genus *Perichæta*, the present one is extremely active in its habits. It is common in the forest mould on the stony terraces of the Arnold River, the outlet of Lake Brunner. The species is readily distinguished from other native forms by its bluish-green colour, its smooth and glossy appearance, and its rapid jerking motions when crawling on the surface of the soil. The cocoons are deposited in the rich mould among the stones and roots of the saplings lying and growing on the terraces. They are dull-yellow in colour, and small for the size of the worm. Following is an abstract of Beddard's paper on the anatomy of this interesting species:—

"I have given this worm the specific name of '*intermedia*' in order to indicate its intermediate characters, but I am not quite certain as to its distinctness from an Australian form recently described by Mr. Fletcher as *Perichæta bakeri*, with which it appears to agree in some structural peculiarities. In Mr. Fletcher's paper no special stress is laid upon the more

important characters of *P. bakeri*, in which it seems to resemble the present species, and to differ markedly from other *Perichætæ*. In any case, therefore, it seems to be desirable to draw the attention of zoologists to this earthworm, as it seems to connect the genus *Perichæta* with other forms. The most remarkable structural peculiarities of *P. intermedia* concern the excretory and reproductive organs. It is a moderately large species, being stout in proportion to its length; its general aspect is very different from that which is characteristic of *Perichæta;* the setæ are not at all conspicuous, and the worm has a smooth, somewhat glandular appearance. This seems to be due to the absence of a ridge in the middle of each segment for the implantation of the setæ. The *buccal lobe* does not divide the peristomial segment. The *clitellum* was not developed in either of my two specimens. The *setæ* form a nearly complete ring round each segment, only failing for a short space in the mid-dorsal and mid-ventral lines. There are no *dorsal pores.* In the neighbourhood of the male genital pores are a number of papillæ. The *male genital pores* are a pair of slit-like orifices on the eighteenth segment, on a line with the setæ, which are almost absent in the space between the two orifices, there being apparently only one seta on the inner side of the pore. The *oviducal pores* are paired, and upon the fourteenth segment; this is unusual, but is occasionally met with in the genus *Perichæta*. The common arrangement is a single median pore. The *nephridiopores* are quite obvious upon most of the segments, and lateral in position.

"*Alimentary Canal.*—The gizzard is situated in the fifth segment; it is very small, and the muscular walls not very thick. The œsophagus is furnished with separate calciferous glands in segments x. and xi. These glands are not, as is so often the case, connected with the lumen of the œsophagus by a narrow duct; they present the appearance of swellings of the œsophagus, and resemble very closely the calciferous glands of *Microchæta* (Beddard, Benham). Though probably formed as two-paired outgrowths of the œsophagus, no trace of a paired arrangement is visible in the adult worm. The *nephridia* are paired; the funnels, as is nearly always the case, open into the segment exterior to that which bears the external orifice. I reserve for the present details as to the structure of the nephridia.

"*Genital Organs.*—The *sperm-sacs* are in ix., x., xi., and xii. The *vasa deferentia* open into segments x. and xi.; the two vasa deferentia unite to form a single tube, the relations of which with the atrium I have not been able to make out with certainty. I believe, however, that it does not open on to the exterior independently of the atrium; there are no

conspicuous penial setæ, but it appeared to me that one or two of the setæ in the immediate neighbourhood of the genital pore were rather longer than the others. The *ovary* is in segment xiii., and the *oviduct* opens into the same segment; there is nothing unusual about either of these organs. The ovary, as in most earthworms, is not a compact organ, but is prolonged into numerous filiform processes. The *egg-sacs* (receptacula ovorum) are very conspicuous structures; they lie upon the posterior surface of the septum separating segments xiii. and xiv., and on either side of the intestine. These organs are larger than is generally the case, and have a racemose appearance; in both these points they present an interesting resemblance to sperm-sacs; furthermore, they contain numerous gregarines. In one specimen, the genital region of which I investigated by transverse sections, the structure of the egg-sacs was a little different from that of other earthworms which I have had the opportunity of studying. The walls are tolerably thick, and appear to be made up of fibres. Interspersed among them are nuclei which are extraordinarily numerous; the blood-supply was not very great, but this may be due to accidental causes. The presence of egg-sacs in *Perichæta* has been noted in but four species. In *P. intermedia* the egg-sacs were filled with mature ova, all of which were surrounded with a perfectly distinct follicular epithelium composed of flattened nucleated cells. In addition to this follicular epithelium—between which and the ovum is a distinct vitelline membrane—many of the ova were also furnished with a small number (four or five) of germinal cells attached to one pole. This is an interesting resemblance to certain of the lower *Oligochæta*, in the majority of which the ova are detached from the ovary, and fall into the egg-sacs in company with a number of germinal cells, which probably serve for the nutrition of the ovum. There are four pairs of *spermathecæ*, occupying segments v.–viii.; each is furnished with a single supplementary pouch of small size: this was conspicuous by reason of its yellow colour, and, as in *P. sumatrana*, was crowded with spermatozoa. The *septum* to which the egg-sacs are attached is one of the specially-thickened septa, of which there are six, dividing segments viii.–xv. The egg-sacs are attached close to the œsophagus, and where the œsophagus perforates the septum there is a space left, through which the egg-sac is prolonged, opening into the interior of the thirteenth segment, and coming into very close relations with the funnel of the oviduct; the passage of the ova into the egg-sac is facilitated by this, and by the fact that the two thick mesenteries which bound segment viii. are closely approximated, so that the actual cavity of the segment is much reduced. The part of the egg-sac nearest to its attachment forms a spacious cavity, undivided

by trabeculæ. I have noticed in this part masses of ovarian tissue containing germinal cells and eggs in all stages of development."

Family PHREORYCTIDÆ.

Genus Phreoryctes, Hoffmeister.

Phreoryctes smithii, Beddard. Trans. Roy. Soc. Edin., vol. xxxv., Part 11 (No. 16).

This species was discovered in 1887 in a forest pool near Lake Brunner, and since then I have found it plentiful in an old swamp on the south bank of the Ashburton River. It inhabits the edges of swamps, frequenting the macerating vegetation, in which the worms frequently coil together into masses. During July and through the spring months they penetrate into the soft clay and mud, and deposit their cocoons. I find the latter more numerous in October and November, and by the month of February the young worms have nearly all emerged. For some time after leaving the cocoons they are extremely minute and delicate, and move slowly through the wet clay and decaying vegetation. The habits of the adults are very sluggish, and their bodies are capable of great distension. Their average measurement is 8in. to 10in. in length, and they can with impunity be stretched to thrice their natural length. Their cocoons are minute pear-shaped yellowish-coloured bodies, and are of a tough leathery texture, and are not difficult to find in the wet clay, or among the masses of fine roots near the edge of the swamp. They are interesting objects under the microscope, and amply repay a patient examination. A number of these have been sent to Mr. Beddard to enable him to study the embryology of the species. The anatomical descriptions of this and the two following aquatic *Oligochæta* are abstracted from Beddard's superbly-illustrated papers, extending over forty pages of the Transactions containing them. The following is the anatomical structure of *Phreoryctes smithii*, as given by the distinguished anatomist:—

"*External Characters.*—The large size of this species, both as regards length and breadth, appears to distinguish it from *P. menkeanus* and *P. filiformis*. It is true that the former species has been found to grow longer, but its thickness is inconsiderable. *P. smithii* can at once be distinguished from these two species by the arrangement and number of the setæ. They commence, as in all *Oligochæta*, on the second segment, and are disposed in four longitudinal rows; but there are *invariably* two closely-approximated setæ in both the dorsal and ventral rows. The second seta does not in any way suggest the idea of its being a 'reserve seta'; indeed, in several

cases 'reserve setæ,' more or less immature, and to the number of two, were present in addition to the fully-formed and functional setæ. The setæ are implanted so as to divide the circumference of the body into four areas; the distance, however, between the ventral pairs is less than that between the dorsal and ventral pair of one side, and the distance between the two dorsal pairs. The arrangement of the setæ, therefore, in *P. smithii* brings the genus nearer to the *Lumbriculidæ*, where there are four rows of *pairs* of setæ. Another point in which *P. smithii* differs from the other species of the genus is in the shape of the setæ. In both the other species the shaft, the portion implanted in the body-wall, is straight: in *P. smithii* this is not the case; the setæ are bent throughout, and have the shape so characteristic of the setæ of the *Oligochæta*.

"*Absence of Genital and Penial Setæ.*—It is important to put on record the fact that in the neighbourhood of the reproductive apertures there is no modification whatever of the setæ. It is not possible to state with absolute certainty that *Phreoryctes* has no genital setæ, but it is at least highly probable that this is the case. This, again, is a point which bears upon the affinities of the genus. Most *Oligochæta* show some modification of the setæ on the genital segments, but this is apparently not so with, *e.g.*, the *Lumbriculidæ*, which family *Phreoryctes* resembles in other particulars.

"*Clitellum.*—In the majority of my specimens the clitellum was developed. The position of the clitellum in the genus has not been hitherto known, and, as this organ is of some little importance in the classification of *Oligochæta*, it is particularly desirable to have some information upon the point. The clitellar region was obvious, in all the specimens which had reached that degree of maturity, by its swollen, distended appearance and whitish colour. The swollen appearance and the white colour are, however, due not so much to the modification of the integument in this region of the body as to the mass of generative products, principally spermatozoa, which are developed in these segments, and cause them to be considerably distended. The comparatively slight increase of thickness in the epidermis of the clitellum, as compared with the epidermis over the general body-surface, is not sufficient to distinguish this part of the body when examined without the aid of a microscope. When the body is slit open, and the integument examined microscopically, the extent of the clitellum is quite obvious; it extends over three complete segments and the part of a fourth. The posterior boundary of the clitellum coincides with the furrow separating segments xiii.–xiv. Anteriorly the clitellum is not so sharply defined; it commences on segment x., at or near the setæ. The clitel-

lum of *P. smithii* therefore occupies three segments and a portion of a fourth, commencing on the tenth and ending at the posterior border of the thirteenth segment. It forms a complete girdle round these segments—*i.e.*, there is no ventral space not invaded by the glandular modification of the integument. The clitellum therefore includes all the apertures of the generative ducts, which are thus in the strictest sense 'intraclitellian.'

"*Vascular System.*—The vascular system of *P. smithii* consists, as in the other two species of the genus, of a dorsal and ventral trunk, which are united by transverse branches. The dorsal and ventral vessels are connected in each posterior segment by a transverse pair of trunks, which do not pass straight from the dorsal to the ventral vessel, but have a very sinuous course. The coils of these lateral vessels are not, however, so complicated as in the anterior segments, and their calibre is also less. The vessels, moreover, are not invested by a thick sheath of peritoneal cells like the anterior lateral trunks. The vascular trunks of these posterior segments are precisely like those of *Phreoryctes filiformis*, as described and figured by Vejdovsky. In *P. menkeanus* the lateral trunks are only connected with the ventral vessel; they arise from the latter, and pass round the circumference of the cœlom for a considerable distance, but do not join the dorsal vessel.

"*Reproductive Organs.*—The testes are, as stated before, two pairs, situated in segments x. and xi.; they are not, however, of a simple conical form in the fully-developed worm, but prolonged into several processes; the digitate shape is due to the rapid and unequal proliferation of the testicular cells. The genera *Lumbricus* and *Allolobophora* (among others) have been distinguished by the form of the testes, which have been figured as of conical form in the one, and digitate in the other: it is very possible that this difference does not really exist, but that it is merely due to the stage of development at which the organs have been studied; such a difference occurs, at any rate, in *Phreoryctes*.

"*Vasa Deferentia.*—There are two pairs of these ducts, which open independently of each other on to segments xi. and xii. The first pair do, indeed, open near to the ventral pair of setæ between these and the dorsal pair; but the second pair are a little different. The vas deferens of each side is much shorter, and opens well in front of the ventral pair of setæ of the twelfth segment, though behind the groove which separates this segment from the eleventh: that there is really this somewhat unexpected difference between the two pairs of vasa deferentia I have been able to prove by longitudinal sections, which are much better than transverse sections for demonstrating such a point. In preparation of the worm,

mounted entire in Canada balsam, some of the orifices of the sexual ducts were quite conspicuous. One of three such preparations which I have shows the external pore of the oviducts, and of the posterior pair of vasa deferentia: in all three cases the orifices are situated on a line with and in front of the ventral setæ; the oviducal pores are placed further forward than the male pore—in fact, on the intersegmental furrow."

The following summary to Mr. Beddard's paper is given by that gentleman as specially characteristic of the genus *Phreoryctes* :—

"1. The body is extremely elongated, sometimes reaching a foot in length, while the diameter is very small.

"2. The prostomium is divided into two by a transverse furrow.

"3. The *setæ* are simple, not bifid; they are disposed in four rows of single setæ, or of pairs of setæ.

"4. * There are no *genital* or *penial setæ*.

"5. * The *clitellum* occupies three to four segments from the tenth to the thirteenth; its epidermis is formed by a layer of glandular cells, differing from the epidermis of the general body-surface by their glandular character and greater length.

"6. The structure of the longitudinal muscles.

"7. * The nephridia commence in the sexually-mature worm in the sixteenth segment.

"8. There are two pairs of testes, in the tenth and eleventh segments.

"9. Two pairs of vasa deferentia opening into the exterior upon the eleventh and twelfth segments in front of the ventral setæ, and opening by wide, simple (not plicated) funnels into the tenth and eleventh segments.

"10. Two pairs of ovaries in segments xii. and xiii.

"11. Two pairs of oviducts opening into the exterior on segments xiii. and xiv., near to the lower line between these segments, and the one in front on a line with the ventral setæ. The oviducts open by wide simple funnels into the interior of segments xii. and xiii. The structure of these organs is exactly that of the vasa deferentia.

"12. Both series of the ducts have the distal region lined with a chitinous membrane indicating (?) their origin from an octodermic invagination.

"13. * The developing spermatozoa are contained in spermsacs, which occupy segments ix. to xiv. (about).

"14. * The ova, which are when adult of very large size,

* The asterisks signify that the statements to which they are appended were made for the first time in the paper from which this abstract is taken.

undergo their development in egg-sacs, which occupy segments xiv. to xvi. (about).

"15. The spermathecæ are present to the number of from two to three pairs in segments vii., viii. (and ix.)."

Genus PELODRILUS, Beddard.

Pelodrilus violaceus, Beddard. Trans. Roy. Soc. Edin., vol. xxxvi., Part 11 (No. 11).

This interesting species occurs in the rich mould on the edge of an old swamp, the property of A. Curtis, Esq., of Tinwald, near Ashburton. In habits, as well as in structure, it occupies an intermediate stage between aquatic and terrestrial worms. When its minute burrows are examined with a lens they are seen to be thickly coated with a semi-transparent fluid. Its very minute cocoons are deposited, like those of the higher forms, outside the walls of the burrows, and occasionally almost flush with them. Like those of the preceding species, they are pear-shaped, and are unlike the oblong-shaped cocoons of several strictly terrestrial species. The following is Beddard's anatomical description of this Annelid:—

"The length of the specimens varies from 1in. to 2in.; they are very slender, and resemble a *Phreoryctes* or *Lumbriculus*. Most of them have the clitellum well developed; and this fixes the period of maturity to the month of August, when they were collected.

"*External Characters.*—(1.) The *prostomium* of *Pelodrilus* is short and blunt, and very inconspicuous in the preserved specimens; it has no resemblance to that of *Phreoryctes*, which is divided by a furrow into two portions. (2.) The *setæ* exist upon all the segments of the body except the first. They are arranged in four couples, both of which are, in the anterior part of the body at any rate, rather lateral in position. I could detect no difference of size between the setæ of the more dorsal and of the more ventral couples, such as I have shown to occur in *Phreoryctes*. The shape of the setæ is in no way distinctive; they agree with those of *Phreoryctes*, the *Lumbriculidæ*, and most earthworms. (3.) *Clitellum:* In *Pelodrilus* the clitellum occupies segments xi.–xiii. It is only developed on the dorsal side of the body. In the region of the clitellum the body is much swollen, owing to the tension caused by the genital products. So far, therefore, as can be said at present, *Pelodrilus* comes nearer to *Phreoryctes* than to the *Lumbriculidæ*. (4.) *Nephridiopores:* These are situated in front of the ventral pair of setæ.

"*Integument.*—The most interesting fact relating to the structure of the body-wall in *Pelodrilus* is its great thickness in the anterior, as compared with the posterior, segments.

This is frequently met with among terrestrial *Oligochæta*, where it appears to have an obvious relation to the density of the medium in which they live. Increased muscular power in the anterior segments is not so much needed by worms which swim in water, and is not developed. *Pelodrilus*, however, does not live in water, like most of its allies, but in marshy land; and its structure bears evidence of its mode of life, not only in the thick longitudinal muscular coat of the anterior segments, but also in the greatly-increased thickness of some of the anterior intersegmental septa. The epidermis consists of the usual glandular cells, between which lie tall interstitial cells. The circular muscular layer is not more than two fibres thick in the anterior thickened region of the body. In connection with the epidermis I may mention the presence of two sucker-like structures, which lie, one behind the other, in the middle ventral line of segment x. These bodies seem to be possibly organs of sense connected with the generative functions.

"*Alimentary Canal.*—This presents the characters that are usually met with in the lower *Oligochæta*—that is, there is no gizzard, and no glands appended to the canal. The buccal cavity occupies the first segment of the body. Its walls consist of little else than a layer of somewhat flattened cells. The pharynx also occupies a single segment—the second. It is chiefly distinguished by the thickened epithelium, developed only on the dorsal side; which begins and ends abruptly. A few muscles attached to the pharynx connect it with the body-wall. The œsophagus is narrow, but the commencement of the intestine is hardly wider. The latter is distinguished by its epithelium being ciliated. The chloragogen cells commence in the fifth segment. It was Claperède who first noticed that the chloragogen layer covering the intestine was a fixed point often characteristic of the species.

"*Nephridia.*—The nephridia, instead of being, as is the rule in the aquatic Annelids, absent in the genital segments, are present in all the segments of the body commencing with the seventh, and excepting the eleventh and twelfth. There is hardly any development of peritoneal cells round the nephridia; certainly the large vesicular cells, which are so often found in the aquatic *Oligochæta*, are absent.

"*Body-cavity.*—The *septa* which separate the cœlom into a series of cavities corresponding to the external segments are replaced in the four anterior segments by irregularly-placed fibres and bundles of fibres passing between the alimentary tract and the parietes; after the fifth segment the regular septa begin. It is interesting to find that the first five of these are very thick, and consist of two distinct muscular coats, whose fibres run in opposite directions. The septa are

cup-shaped, with the concavity directed forwards, and in the segments which contain the sperm-sacs and ovisacs this concavity is much emphasized by the stretching of the septa caused by the growth of the sacs in question. As far as I am aware, *Pelodrilus* is the only instance of an Oligochæt which Claperède would undoubtedly have referred to his group of *Limicolæ*, where this increase in thickness of the anterior intersegmental septa is met with. It may very possibly have a relation to the habitat of the worm in soil, and not in the softer mud at the bottom of a lake or river, and in any case it shows that no importance can be attached to the presence of these thickened septa in earthworms as a character distinguishing them from the lower *Oligochæta.* In view, however, of other points in which *Pelodrilus* resembles the higher *Oligochæta*, this character perhaps gains an additional importance.

"*Septal Glands.*—The septal glands are found in segments v.–vii.: they form a series of paired structures lying on the anterior face of the cup-shaped septa which lie between these segments. I could not find any evidence of their possessing a central lumen such as has been described by various writers. In all my sections the septal glands were undoubtedly solid structures, though often furnished with a fibrous côre. They have a glandular appearance, and are pear-shaped. The structure of these glands, in fact, is very much like that of the 'capsulogenous' glands in *Perichæta.* In *Pelodrilus* I must confess to having been unable to trace the ducts of the septal glands through the pharyngeal epithelium. They appeared to end at the bases of these cells. It is almost unnecessary to point out that there is every probability of the pharynx being in *Pelodrilus* of stomodæal origin.

"*Testes.*—There are two pairs of testes, placed in segments x. and xi., and attached to the anterior septa of their segments. They are of considerable size when fully developed, and branched at their free extremities. In the mature worm the testes are nearly always incomplete in number, owing, presumably, to the fact that the germinal cells of one or more of the gonads have been transferred to the interior of the spermsacs.

"*Vasa Deferentia.*—The vasa deferentia are remarkably long and greatly coiled. The vas deferens is for the most part extremely thin, though it widens out just before joining the funnel, and also for some little distance in front of the external orifice. In the extremely thin and much-coiled vasa deferentia, *Pelodrilus* differs from all the *Oligochæta*, to which it presents other points of affinity. The structure of the vasa deferentia is not in any way peculiar; they are, as is always the case, composed of a single layer of cubical cells,

and are covered by a delicate layer of peritoneum. The communication of the vasa deferentia with the exterior is effected in a way which is unique among the *Oligochæta*. There is no trace of an atrium—a structure which is present in all the *Lumbriculidæ*. The vasa deferentia open directly on to the exterior, as in *Phreoryctes* and the *Lumbricidæ*. The male apertures are situated within the clitellum, and are conspicuous when this region of the body is examined in a specimen mounted entire. I have been able to recognise two pairs of orifices placed upon the twelfth segment. In longitudinal sections two distinct male apertures are to be found on each side of the body, placed one in front of the other, and on a line with the oviducal pores, as well as with the apertures of the spermathecæ. The two male pores of each side of the body are very much nearer to each other than the posterior of the two is to the oviducal pore. It follows, therefore, that, while the posterior of the two funnels is connected with a vas deferens which opens upon the following segment, the anterior vas deferens traverses *two* segments before it communicates with the exterior. This is the only instance known to me of an Annelid which would obviously belong to Claperède's division of the *Limicolæ*, in which the aperture of the vas deferens is situated further behind its funnel than the following segment; and this genus forms a unique instance of the vasa deferentia of each side opening on to the same segment, but by separate orifices. In the position of the funnel and male orifices this genus appears to be intermediate between *Phreoryctes* on the one hand and *Eisenia* (=*Tetragonurus*) on the other. In *Phreoryctes* each vas deferens opens separately on the segment behind that which contains the funnel; in *Pelodrilus* the anterior male pore has receded until it has come to lie in the same segment with the posterior pore.

"*Ovaries*.—There are a single pair of ovaries in segment xii. Each is attached close to one side of the ventral nerve-cord. The ovary is of an oval, somewhat pear-shaped form; it is for the most part made up of small germinal cells, and contains one or two ova in advanced stages of development. The ova, however, do not undergo their entire development in the ovary; masses of cells consisting of developing ova are, apparently, from time to time broken off, and undergo their further development in the egg-sac. The fully-mature ova are laden with yolk-granules, and are of very large size; a single ovum will extend through two or three segments.

"*Oviducts*.—The two oviducts open on to the intersegmental groove xii./xiii. What strikes one about the oviducts of this and other '*Limicolæ*' is the small size, as compared with the gigantic ova which have to find their way out of the body-cavity through them.

"*Spermathecæ.*—*Pelodrilus* is furnished with a single pair of spermathecæ, in segment viii. Each opens close to the boundary-line between segments vii. and viii., at a spot corresponding to the male apertures—*i.e.*, between the dorsal and ventral setæ, though nearer to the latter. The spermathecæ are very large, and each is doubled upon itself. I usually found clumps of small spherical granular cells, each with a minute but darkly-staining nucleus near to the blind extremity of the spermathecæ. I am uncertain whether or not to regard these as parasites.

"There can be, I think, little doubt that *Pelodrilus* should be included in the family *Phreoryctidæ*. It agrees with *Phreoryctes* in the following assemblage of characters: (1) Testes in x. and xi.; (2) sperm-ducts, two pairs opening separately; (3) atrium absent; (4) spermathecæ anterior to testes; (5) hearts long, thin, and much convoluted. The more important points of difference between *Pelodrilus* and *Phreoryctes* are these: (1) Sperm-ducts greatly coiled, both on each side opening upon the twelfth segment, though separately; (2) only one pair of ovaries in xii., and one pair of oviducts opening between xii. and xiii.; (3) the presence of septal glands; (4) nephridia present in some of the genital segments; (5) clitellum occupying only three segments (xi.–xiii.), and developed only ventrally; setæ of segment xii. absent; (6) some of anterior septa thickened. These structural characters of *Pelodrilus* do not indicate much affinity to any other group of the lower *Oligochæta*. The greatly-coiled sperm-ducts recall those of the *Tubificidæ* and *Enchytræidæ*, but other characters do not permit of the establishment of any close relationship between *Pelodrilus* and either of these two families. On the other hand, it does seem possible to indicate some relationship between *Pelodrilus* and the higher *Oligochæta* (earthworms), though these are not sufficiently pronounced to admit of a comparison between *Pelodrilus* and any particular family or families of that group.

"The general resemblances to the higher forms, other than those shared by *Phreoryctes*, are as follows: (1) Persistence of nephridia in certain of the genital segments (this is shared by *Lumbriculus*); (2) several of anterior intersegmental septa greatly thickened; (3) one of the pairs of vasa deferentia traverses two segments between the internal and external orifice. *Phreoryctes* itself comes nearer to earthworms than does any other genus among the lower *Oligochæta*, and *Pelodrilus* serves to increase the closeness of the family *Phreoryctidæ* to the higher *Oligochæta*."

Family PHREODRILIDÆ.

Genus PHREODRILUS.

Phreodrilus subterraneus, Beddard.

This species was described by Beddard from two specimens obtained from a pipe-well at Ashburton. They were presented to me by Mrs. T. Sealy, who very kindly preserved them alive in fresh water, and sent them to me. I had previously heard of the occurrence of minute worms in the wells on the Plains, but these were the first specimens I obtained. Like the new and peculiar family (*Phreatocidæ*) of Crustacea described by Mr. C. Chilton, F.L.S., from the subterranean water of the Canterbury Plains, Beddard had also to create a new family for its reception, of which the species remains at present the only representative. At present I cannot give any account of its habits, as the extreme difficulty of studying such in a state of nature precludes the possibility of my doing so. Judging, however, from its external structure, and from its habits in a small aquarium, it seems peculiarly fitted for its subterranean aquatic life. Its motions are extremely active in the water, and it moves rapidly through the small interstices in the shingle on the bottom of the aquarium. The long setæ visible to the naked eye are probably used by the worms as paddles when moving through the water and shingle which they inhabit. The food and breeding-habits of *P. subterraneus* are perhaps a little puzzling at present; yet they cannot differ very materially from those of other aquatic oligochætous worms. Many parts of the Canterbury Plains are covered with a stratum of clay varying in thickness from 6ft. to 15ft., including the surface-soil. In the normal condition of the subterranean water the lower few feet of the soft clay is saturated, and affords perfect conditions for the worms to pair and deposit their cocoons in it. Decayed logs of wood and other vegetable matter have recently been found imbedded in the clay; the latter thus intermixed with decaying vegetable substances would, I think, afford good feeding- and breeding-grounds for the species. The following abstract is given from Beddard's valuable paper on its anatomical structure:—

"*External Characters.*—Each measures about 2in. in length; even when preserved they have a graceful appearance, due to the delicate, almost transparent, body-walls, and to the projection of the long setæ of the dorsal rows. The characters of the setæ alone show that this Annelid conforms to no genus of which we have any adequate description. As in the majority of the *Tubificidæ* and the *Naidomorpha*, the dorsal setæ are capilliform; but in *Phreodrilus* there is only a single dorsal seta on each side of the body in the posterior segments. The portion implanted in the

body is straight and of some thickness; the free portion is slightly curved, and tapers gradually towards its extremity. Each of these setæ was invariably accompanied by two reserve setæ of the same form, one on each side. In no instance did I observe more than a single mature seta belonging to each of the two dorsal series. On the other hand, the ventral setæ were as invariably paired. The setæ of the ventral series are of two kinds; a single set of each kind are found in every pair. In both cases the setæ approximate in shape to those of the *Lumbriculidæ* and of earthworms; the extremity is not bifid, and shows no traces of having been worn down. The imbedded portion of the setæ is nearly straight, but the free portion is much curved—more so than in the setæ of the two groups referred to. This, however, only applies to the larger of the two setæ in each pair; the smaller seta has a less-marked curvature. I could observe no difference in the setæ in the different regions of the body; but, as the worm was not fully mature, it does not follow that such differences may not be developed later. In every case the setæ protruded from the apices of well-marked papillæ. The *prostomium* is obtuse, ending in a wide truncated anterior margin. The *clitellum* was visible in neither of the two specimens. The *male genital apertures* are paired, and lie on segment xii., in front of the ventral setæ. The *oviducal pores* occupy a corresponding position in the interval between segments xii. and xiii. The *spermathecal pores* lie in front of the dorsal setæ of segment xiii.

"*Integument.*—The integument had the same structure throughout. In neither of the two specimens which I examined was the clitellum developed, nor was there the very least indication of the position of this organ, such as is sometimes afforded in immature *Oligochæta*. It is evident, therefore, that *Phreodrilus*, like some other genera, may reach a considerable degree of sexual maturity of the internal organs without a corresponding development of the clitellum.

"*Nephridia.*—These organs commence only in the fourteenth segment (in the worm with sexual organs); the whole organ is furnished with the large vesicular cells so commonly found attached to the nephridia of the lower *Oligochæta*. The funnel opens into the segment in front of that in which the organ lies; it is small, and is placed to the side of the nerve-cord.

"*Alimentary Tract.*—As no known genus of the aquatic *Oligochæta* possesses a gizzard,* it is almost unnecessary to state that *Phreodrilus*, which would certainly have been in-

* "The so-called gizzard of the *Naidomorpha* seems to be hardly comparable with the gizzard of earthworms."—Beddard.

cluded by Claperède in his *Oligochæta Limicolæ*, has no trace of such a structure. The alimentary canal of *Phreodrilus* has in other respects the usual simple structure of the lower *Oligochæta*. It is also, as in the *Naidomorpha* and *Enchytræidæ*, ciliated throughout, with the exception only of the buccal cavity. The cilia of the pharynx and œsophagus are shorter than those of the intestine, but not less obvious. The buccal cavity is distinguished by the short columnar cells by which it is lined. It is abruptly marked off from the pharynx, particularly on the dorsal side; the obvious demarcation between the two structures is not, however, due to a sudden change in the character of the cells, but to their very rapid increase in length; the dorsal wall of the pharynx is lined by very tall cells, which in the space of three or four cells change their character to the comparatively flattened epithelium of the buccal cavity. The posterior limits of the pharynx are not at all clearly marked; the epithelium very gradually decreases in height, and it is impossible to fix upon any point which might be termed the junction of the pharynx with the œsophagus. The calibre of the intestine is greater than that of the œsophagus, and its walls are in the same way highly vascular. The transition between œsophagus and intestine is not very abrupt; the intestine seems to commence in segment xiii.

"*Vascular System.*—In longitudinal sections of *Phreodrilus* two perfectly-separate vessels may be observed running along the dorsal wall of the œsophagus. Their course is fairly straight. The two vessels are different from each other in structure, and cannot therefore be confounded in sections where sometimes only one of the two was visible in a particular segment. The vessel, which is closely applied to the dorsal wall of the œsophagus, is extremely thin-walled, and completely filled with coagulated blood. It resembles in these particulars the ventral blood-vessel. In both vessels, particularly in the supra-intestinal, it is easy to see that the blood is a corpusculated fluid; here and there oval bodies, which have in every respect the appearance of the nuclei in the endothermal lining, may be seen imbedded in the coagulated yellow blood. There is little doubt that Lankester's description of corpuscles in the earthworm's blood will be extended to other—to perhaps all the groups of *Oligochæta*, in many of which they have been observed by Vejdovsky. Here and there the endothelium lining the blood-vessels—particularly at the points where they traverse the intersegmental septa—is thickened to form valve-like structures. These agglomerations of cells may be the localities where the blood-corpuscles take their origin through the rapid proliferation of the lining membrane, as Vejdovsky has suggested. The supra-intestinal

vessel is connected with the blood-supply of the intestines, and it gives off from the lower side numerous branches, which at once break up and form a plexus lying between the œsophageal or intestinal walls. The supra-intestinal vessel is also connected in the twelfth segment directly with the ventral vessel. This connection is effected by a pair of great coiled vessels, which I describe later as blood-glands. Further forward the supra-intestinal vessel appears to have no connection with the ventral vessel; there are, however, a number of perivisceral trunks, thin and coiled, which surround the œsophagus and communicate with the ventral trunk. These take their origin from the dorsal blood-vessel. We thus have in *Phreodrilus*, as in *Lophochæta* and *Bothrioneuron*, a double system of perivisceral trunks, one set connected with the dorsal and the other with the supra-intestinal vessel. As in *Lophochæta*, there is only one pair of vessels belonging to the latter set. It seems to me, however, to be far from certain that the dorsal vessel of *Phreodrilus* is the homologue of the dorsal vessel in *Tubifex* and some of the lower forms. The question then arises, To which of the two vessels of *Phreodrilus* does the dorsal vessel of *Pelodrilus* and other of the lower *Oligochæta* correspond? The relations of the single dorsal vessel, which is present in the posterior segments of *Phreodrilus*, to the intestinal, suggests that *it* is the equivalent of the single dorsal vessel of other *Oligochæta*: in this case the vessel which I have termed 'dorsal vessel' in the anterior segments will be unrepresented in these *Oligochæta*. There can, I think, be little doubt that the two dorsally-placed blood-vessels of *Phreodrilus* are the equivalents of the two in *Perichæta*, *Acanthodrilus*, and a large number of earthworms. In the simpler forms of *Oligochæta*, then, the dorsal vessel in most cases has disappeared, while the persistent supra-intestinal takes on its functions as well as its own.

"*Testes.*—The testes of *Phreodrilus* lie partly in segment x., but chiefly in segment xi. In longitudinal sections I have found a perfect continuity between the portions of the testes which lie in front of and behind this septum. There is, however, no doubt that in *Phreodrilus* the germinal tissue is perfectly continuous through the septum. At both extremities each testis is frayed out into irregularly-shaped processes, which contain the germinal cells in the most advanced stage of development. The body-cavity in the neighbourhood of the gonad is occupied by a quantity of developing and fully-developed spermatozoa. There was no trace of a sperm-sac, which is a nearly universal structure among the *Oligochæta*. As ripe spermatozoa were abundant in the body-cavity and in the circumatrial sac, I think it probable that no sperm-sac other than the circumatrial space is ever developed. . . .

"*Vas Deferens.*—*Phreodrilus* is furnished with only a single pair of vas deferens funnels, situated in segment xi. It is comparatively small, and markedly cup-shaped. The funnel is lined by a single layer of epithelial cells, which are furnished with particularly long cilia. The funnel on each side of the body is connected with the vas deferens, which is a narrow tube lined by comparatively few cells.

"*Atria.*—One remarkable point about the atrium of *Phreodrilus* is its great length; but, instead of extending through a large number of segments, as in *Latroa*, the entire atrium is contained in the twelfth segment. It is, however, coiled upon itself several times, and is thus able to be stowed away in one segment. The structure of the atrium is the same throughout. The epithelium of the whole atrium was thrown into folds. I could detect no trace of cilia anywhere; and, as the cilia of the vas deferens and other organs were beautifully preserved, I am disposed to think that the atrium of this genus is not ciliated during life. At the external pore the atrial epithelium passes without any break into the epidermis. There was no trace of a penis or any specialisation in the distal section of the atrium.

"*Ovaries.*—These gonads are paired, and arise from the intersegmental septum between segments xi.–xii. in a position corresponding to that of the testes; they lie therefore on the twelfth segment below the funnel of the vas deferens; but they do not also extend into the segment in front as the testes do. The ovaries are limited to the twelfth segment. I have been able to observe certain stages in the development of the ova which show a remarkable parallelism to the development of the spermatozoa. Many clumps of developing ova were to be seen lying in various parts of the cœlom of segment xii. I found others (not so many) in segment xi. among the developing spermatozoa. This may possibly be due to the presence of an additional pair of ovaries belonging to the eleventh segment, but I have no other evidence which points to such a conclusion. The further stages in the development of the ova are as follow: The central mass of protoplasm is always without a nucleus, but soon comes to be clearly separated from the cells surrounding it; it assumes a polygonal form. The surrounding cells, which form a complete investment for the central mass, lose their pear-shaped outline, and become angular when they are in contact with the neighbouring cells and with the central mass of protoplasm. The outer surface is rounded and convex.

"*Oviduct.*—The oviduct, as in the *Lumbriculidæ* and *Tubificidæ*, is very short, and consists of little more than the

funnel; the duct leading to the exterior is very short. The oviduct-funnel opens into the twelfth segment, and the external pore lies on the boundary-line between this segment and the thirteenth. In the only specimen which I studied by means of sections the oviduct was not ciliated, and the funnel also had evidently not arrived at maturity. It is interesting to note that the female organs of this worm are not fully mature at the same time as the male organs. There appears to be here, as in other hermaphrodite organisms, a dichogamy."

The generic characters of *Phreodrilus* are thus briefly stated by Beddard: "A single pair of very elongated and coiled spermathecæ, opening on to the exterior in front of dorsal setæ of segment xiii. Septal glands present, connected with pharynx. Nephridia wanting in anterior segments. No special sperm-sacs or egg-sacs"(?).

Note.—Since the foregoing was compiled Sir Walter Buller, F.R.S., has sent me a copy of a recent paper* on the habits of British earthworms. The reverend author devotes a section of the paper to "The Tree-worms of Great Britain," and describes them as "that group of worms whose principal habitat is the old and decaying stumps or trunks of fallen trees, and whose chief service consists in the breaking-up of useless timber, and reducing it to vegetable mould." The habits and specific characters of the six species he enumerates are clearly defined, and it is interesting to note that they belong to different genera from the species which are frequently found in decaying timber and rotten logs in the New Zealand forests. The latter consist chiefly of *Perichæta*—worms whose active habits and muscular structure fit them for burrowing into decaying wood. I have described the habits of one species in my former paper.

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* "Studies of British Tree- and Earth-worms," by the Rev. H. Friend, F.L.S. "Journal of the Linnean Society," vol. xxiv., p. 292.

ART. XVI.—*Contributions to the Molluscan Fauna of New Zealand.*

By H. SUTER.

Communicated by Professor Hutton.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1892.*]

I.—*Molluscan Fauna of Riccarton Bush, Christchurch.*

Fam. PHENACOHELICIDÆ.

Gen. THALASSOHELIX, Pilsbry, 1892.

Th. lambda, Pfeiffer.

Gen. ALLODISCUS, Pilsbry, 1892.

A. tullius, Gray.

Gen. THERASIA, Hutton, 1884.

Th. valeria, Hutton.

Gen. PHENACOHELIX, Suter, 1892.

Ph. iota, Pfeiffer, var.

Gen. FLAMMULINA, Von Martens, 1873.

F. zebra, Le Guillou.
F. crebriflammis, Pfeiffer.

Gen. LAOMA, Gray, 1849.

Sub-gen. PHRIXGNATHUS, Hutton, 1883.

Ph. regularis, Pfeiffer.
Ph. haasti, Hutton.

Fam. PATULIDÆ.

Sub-fam. CHAROPINÆ.

Gen. ENDODONTA, Albers, 1850.

E. varicosa, Pfeiffer (= *timandra*, Hutton).

Gen. CHAROPA, Albers, 1860.

Ch. pseudocoma, n. sp.
Ch. bianca, Hutton.
Ch. anguiculus, Reeve.
Ch. brouni, Suter.
Ch. tau, Pfeiffer (= *sylvia*, Hutton).
Ch. zeta, Pfeiffer.
Ch. epsilon, Pfeiffer.

Fam. JANELLIDÆ.

Gen. JANELLA, Gray, 1850.

J. papillata, Hutton.

Fam. HYDROBIIDÆ.

Gen. POTAMOPYRGUS, Stimpson, 1865.

P. corolla, Gould.

Fam. HYDROCENIDÆ.

Gen. HYDROCENA, Parreyss, 1847.

H. purchasi, Pfeiffer.

II.—*Molluscan Fauna of the Hunua Range, Auckland.*

The shells from this locality were collected and kindly forwarded to me by Captain Thomas Broun, of Karaka, Drury.

Fam. TESTACELLIDÆ.

Gen. ELÆA, Hutton, 1884.

E. coresia, Gray.
E. jeffreysiana, Pfeiffer.

Fam. PHENACOHELICIDÆ.

Gen. THALASSOHELIX, Pilsbry, 1892.

Th. ziczac, Gould (=*portia*, Gray).
Th. neozelanica, Gray.

Gen. ALLODISCUS, Pilsbry, 1892.

A. mirandus, Hutton.
A. urquharti, n. sp.

Gen. THERASIA, Hutton, 1884.

Th. celinde, Gray.
Th. tamora, Hutton.

Gen. PHENACOHELIX, Suter, 1892.

Ph. iota, Pfeiffer.
Ph. granum, Pfeiffer.

Gen. SUTERIA, Pilsbry, 1892.

S. ide, Gray.

Gen. FLAMMULINA, Von Martens, 1873.

F. perdita, Hutton.
F. chiron, Gray.

Sub-gen. CALYMNA, Hutton, 1884.

C. feredayi, Suter.

Gen. LAOMA, Gray, 1849.

L. leimonias, Gray.
L. pœcilosticta, Pfeiffer.
L. marina, Hutton, et f. *albina*.

Sub-gen. PHRIXGNATHUS, Hutton, 1883.

Ph. mariæ, Gray.
Ph. celia, Hutton.
Ph. allochroidus, Suter.
Ph. microreticulatus, Suter.
Ph. conella, Pfeiffer.
Ph. erigone, Gray.
Ph. transitans, Suter.

Fam. PATULIDÆ.

Sub-fam. CHAROPINÆ.

Gen. ENDODONTA, Albers, 1850.

E. varicosa, Pfeiffer (= *timandra*, Hutton).

Sub-gen. PTYCHODON, C. F. Ancey, 1891.

P. hunuaensis, n.sp.

Gen. CHAROPA, Albers, 1860.

Ch. coma, Gray.
Ch. gamma, Pfeiffer.
Ch. eta, Pfeiffer, var. *maculata*, Suter.
Ch. tau, Pfeiffer (= *sylvia*, Hutton), et f. *albina*.
Ch. tapirina, Hutton.
Ch. epsilon, Pfeiffer.
Ch. subantialba, Suter.

Fam. BULIMULIDÆ.

Gen. CARTHÆA, Hutton, 1884.

C. kiwi, Gray.

Fam. HELICTERIDÆ.

Gen. TORNATELLINA, Beck, 1837.

T. neozelanica, Pfeiffer.

Fam. HYDROBIIDÆ.

Gen. POTAMOPYRGUS, Stimpson, 1865.

P. cumingiana, Fischer.

Fam. CYCLOPHORIDÆ.

Gen. LAGOCHILUS, Blanford, 1864.

L. cytora, Gray.
L. torquillum, n. sp.

Fam. CYCLOSTOMATIDÆ.

Gen. Realia, Pfeiffer, 1851.

R. egea, Gray.
R. carinella, Pfeiffer.

Fam. HYDROCENIDÆ.

Gen. Hydrocena, Parreyss, 1847.

H. purchasi, Pfeiffer.

III.—*Molluscan Fauna of the Pirongia Mountain, Kawhia.*

Mr. A. T. Urquhart, of Karaka, Drury, has been collecting on part of this mountain, and I am indebted to him for the following molluscs :—

Fam. TESTACELLIDÆ.

Gen. Elæa, Hutton, 1884.

E. coresia, Gray.

Fam. PHENACOHELICIDÆ.

Gen. Thalassohelix, Pilsbry, 1892.

Th. neozelanica, Gray.

Gen. Allodiscus, Pilsbry, 1892.

A. tullius, Gray.
A. adriana, Hutton.
A. mirandus, Hutton.
A. urquharti, n. sp.

Gen. Therasia, Hutton, 1884.

Th. celinde, Gray.
Th. tamora, Hutton.
Th. traversi, E. A. Smith.

Gen. Phenacohelix, Suter, 1892.

Ph. iota, Pfeiffer.

Gen. Suteria, Pilsbry, 1892.

S. ide, Gray.

Gen. Flammulina, Von Martens, 1873.

F. perdita, Hutton.
F. zebra, Le Guillou.

Gen. Laoma, Gray, 1849.

L. leimonias, Gray.
L. pœcilosticta, Pfeiffer.
L. marina, Hutton.
L. pirongiaënsis, n. sp.

Sub-gen. PHRIXGNATHUS, Hutton, 1883.

Ph. mariæ, Gray.
Ph. ariel, Hutton.
Ph. erigone, Gray,
Ph. microreticulatus, Suter.
Ph. allochroidus, Suter.
Ph. „ „ var. *sericatus*, Suter.
Ph. phrynia, Hutton.
Ph. glabriusculus, Pfeiffer.

Fam. PATULIDÆ.

Sub-fam. CHAROPINÆ.

Gen. ENDODONTA, Albers, 1850.

E. varicosa, Pfeiffer (= *timandra*, Hutton).

Sub-gen. PTYCHODON, C. F. Ancey, 1891.

P. pseudolcioda, Suter.

Gen. CHAROPA, Albers, 1860.

Ch. coma, Gray.
Ch. gamma, Pfeiffer.
Ch. tau, Pfeiffer (= *sylvia*, Hutton).
Ch. epsilon, Pfeiffer.
Ch. huttoni, Suter.

Fam. BULIMULIDÆ.

Gen. CARTHÆA, Hutton, 1884.

C. kiwi, Gray.

Fam. CYCLOPHORIDÆ.

Gen. LAGOCHILUS, Blanford, 1864.

L. cytora, Gray.
L. pallidum, Hutton.
L. hedleyi, n. sp.

Fam. HYDROCENIDÆ.

Gen. HYDROCENA, Parreyss, 1847.

H. purchasi, Pfeiffer.

IV.—*Molluscan Fauna of Waimarama, Hawke's Bay.*

Mr. A. Hamilton, of Dunedin, collected a large number o shells at flood-margin of a stream at Waimarama, and kindly intrusted them to me for identification.

Fam. PHENACOHELICIDÆ.

Gen. PHACUSSA, Hutton, 1883.

Ph. hypopolia, Pfeiffer.

Gen. THALASSOHELIX, Pilsbry, 1892.

Th. propinqua, Hutton.

Gen. ALLODISCUS, Pilsbry, 1892.

A. tullius, Gray.
A. planulatus, Hutton.
A. mirandus, Hutton.

Gen. THERASIA, Hutton, 1884.

Th. tamora, Hutton.

Gen. PHENACOHELIX, Suter, 1892.

Ph. iota, Pfeiffer.
Ph. granum, Pfeiffer.

Gen. LAOMA, Gray, 1849.

L. leimonias, Gray.
L. marina, Hutton.

Sub-gen. PHRIXGNATHUS, Hutton, 1883.

Ph. erigone, Gray.
Ph. phrynia, Hutton.
Ph. conella, Pfeiffer.
Ph. glabriusculus, Pfeiffer.
Ph. pumilus, Hutton.
Ph. raricostatus, Suter.
Ph. allochroidus, Suter.
Ph. " " var. *lateumbilicatus*, Suter.

Fam. PATULIDÆ.

Sub-fam. CHAROPINÆ.

Gen. ENDODONTA, Albers, 1850.

E. varicosa, Pfeiffer (= *timandra*, Hutton).

Sub-gen. PTYCHODON, C. F. Ancey, 1891.

P. pseudoleioda, Suter.
P. microundulata, Suter.
P. wairarapa, Suter.
P. hunuaënsis, n. sp.

Gen. CHAROPA, Albers, 1860.

Ch. coma, Gray.
Ch. segregata, n. sp.
Ch. gamma, Pfeiffer.
Ch. epsilon, Pfeiffer.
Ch. eta, Pfeiffer.
Ch. bianca, Hutton.
Ch. tapirina, Hutton.

Ch. tau, Pfeiffer (= *sylvia*, Hutton).
Ch. zeta, Pfeiffer.
Ch. colensoi, Suter.
Ch. subantialba, Suter.

Sub-gen. TESSERARIA, Böttger, 1881.

T. neozelanica, Pfeiffer (= *Pupa neozelanica*, Pf.).

Fam. HELICTERIDÆ.

Gen. TORNATELLINA, Beck, 1837.

T. neozelanica, Pfeiffer.

Fam. HYDROBIIDÆ.

Gen. POTAMOPYRGUS, Stimpson, 1865.

P. corolla, Gould.

Fam. CYRENIDÆ.

Gen. PISIDIUM, C. Pfeiffer, 1821.

P. lenticula, Dunker.

ART. XVII.—*Notes on New Zealand Insects.*

By H. SUTER.

Communicated by Professor Hutton.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1892.*]

SOME time ago the following papers came under my notice, containing descriptions of new species:—

I.—*The Ants of New Zealand.*

By Prof. Dr. Aug. Forel, Zurich (Switzerland).*

1. Sub-fam. CAMPONOTIDÆ, Forel.

Gen. LASIUS, Fabr.

Sub-gen. PROLASIUS, *nov. sub-gen.*

P. advena, Smith (= *Formica advena*, Smith; *Prenolepis advena*, Mayr).

Hab. Forty-mile Bush, North Island; Riccarton Bush, near Christchurch (H. Suter).

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* Mittheil. der Schweiz. Entomolog. Gesellsch., Bd. 8, Heft 9.

Gen. Camponotus, Mayr.

C. ectatommoides, n. sp.
Hab. The New Zealand habitat seems doubtful; very likely Australian.

2. Sub-fam. DOLICHODERIDÆ, Forel.

Not yet found in New Zealand.

3. Sub-fam. PONERIDÆ, Lep.

Gen. Ponera, Latr.

P. castanea, Mayr, 1865 (= *P. castanea*, Smith, 1876).
Hab. Drury (Capt. T. Broun).

Gen. Ectatomma, Smith.

Sub-gen. Rhytidoponera, Mayr.

R. mayri, Emery.
The New Zealand habitat doubtful. Very likely from East Australia.

Sub-gen. Acanthoponera, Mayr.

A. brounii, n. sp.
Hab. Drury (Capt. T. Broun).

Gen. Amblyopone, Erichson.

A. cephalotes, Smith.
Hab. Drury (Capt. T. Broun).

A. saundersi, n. sp.
Hab. Drury (Capt. T. Broun).

4. Sub-fam. DORYLIDÆ, Shuck.

Hitherto not found in New Zealand.

5. Sub-fam. MYRMICIDÆ, Lep.

Gen. Orectognathus, Smith.

O. antennatus, Smith.
Hab. Drury (Capt. T. Broun).

O. perplexus, Smith.
Hab. Mercury Bay (Capt. T. Broun).

Gen. Strumigenys, Smith.

S. antarctica, n. sp.
Hab. Drury (Capt. T. Broun).

Gen. HUBERIA, Forel.

H. striata, Smith (= *Tetramorium striatum*, Smith).
Hab. Hooker Valley (H. Suter). Ashburton (W. W. Smith).

H. striata, var. *rufescens*, n. var.
Hab. Pirongia Mountain (A. T. Urquhart).

Gen. MONOMORIUM, Mayr.

M. antarcticum, White (= *M. fulvum*, Mayr).
Hab. Found almost everywhere in New Zealand.

M. nitidum, Smith (= *Tetramorium nitidum*, Smith).
Hab. North and South Islands.

M. suteri, n. sp.
Hab. Ashburton (W. W. Smith).

M. smithii, n. sp.
Hab. Ashburton (W. W. Smith).

II.—*On some New Orthoptera.*

By Alph. Pictet and H. de Saussure, Geneva,* Switzerland.

Tribus STENOPELMATINÆ.

Gen. DEINACRIDA, White.

D. maori, n. sp.
Hab. Hooker Valley (H. Suter).

Gen. ONOSANDRUS, Stal.

O. maori, n. sp.
Hab. Hooker Valley (H. Suter).

Gen. PHARMACUS, n. gen.

Ph. montanus, n. sp.
Hab. On snow at about 7,000ft. altitude, vicinity of Mount Cook (Mr. Mannering).

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* Mittheil. der Schweiz. Entomolog. Gesellsch., Bd. 8, Heft 8.

Art. XVIII.—*An Enumeration of the* Janellidæ.

By C. Hedley, F.L.S., Assistant in Zoology, Australian Museum.

Communicated by Professor F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 2nd June, 1892.*]

Of the components of the land molluscan fauna of New Zealand none are more striking on first appearance and more interesting upon subsequent investigation than the bitentaculate slugs. They belong to an order whose extent, distribution, and classification appear to be but little known. Thus, a writer in the Ann. Mag. Nat. Hist., February, 1874, p. 90, states that this family "is found only in Australia and New Zealand," and naturally draws the erroneous deduction of a former direct land-communication between the two countries. Mr. T. D. A. Cockerell offers (Proc. Z. S., 1891, p. 215) a summary of this family, remarking that he is "able to classify the generic groups more clearly than has been done before." His satisfaction is scarcely shared by his fellow-students of the Mollusca, and some of the more flagrant errors in this mischievous essay have been exposed already (Ann. Mag. Nat. Hist. (6), ix., pp. 169–171). For want of works of reference, the writer failed to include in a notice of this family several of its members (Proc. Roy. Soc. Queensland, vol. v., pp. 162–173). It has therefore occurred to him that an enumeration and some discussion of the known forms might be of interest to New Zealand naturalists.

In the ensuing list only the valid species are numbered.

Family JANELLIDÆ, Gray, 1853.

Synonyms. — *Aneiteadæ*, Gray, 1860; *Athoracophoridæ*, Fischer, 1883; *Janellinæ*, Cockerell, 1891; *Hyalimacinæ*, Godwin-Austen, 1882; *Succineidæ* (in part), auctorum.

Descriptions.—Ann. Mag. Nat. Hist. (2), xii., p. 415; *op. cit.* (3), vi., p. 195; Manual N.Z. Mollusca, p. 26; Land and Freshwater Mollusca of India, p. 59; Manuel de Conchyliologie, p. 492; Genera of Recent Mollusca, ii., p. 229; Proc. Roy. Soc. Queensland, v., p. 167; Proc. Zool. Soc., 1891, p. 215; Zeitschrift für Zool., xv., p. 83; &c.

Obs.—The minuteness of the rachidian mentioned by Fischer is not a family but a specific character. The contractile property of the tentacles may prove a family character.

Classification based upon a single feature has never proved to be natural—that is to say, has never arranged its subjects

in the order of their blood-relationship. A classification, to be natural, should be founded upon the aggregate characters, and the arrangement of the pulmonate Gasteropoda by their jaws must be discarded, to share the fate of every such system since the days of Linné. No more unnatural juxtaposition was effected in classification by the jaw than that which subordinated the *Janellidæ* to the *Succineidæ*. The only argument that justified this arrangement would logically include the Cephalopoda, since they similarly possess an elasmognathous jaw. That certainly is the only resemblance between *Succinea* and *Sepia*, but it is also the only resemblance between *Succinea* and *Aneitea*. Indeed, the gap between *Succinea* and *Aneitea* appears to the writer to be wider far than that between the former and either *Helix* or *Zonites*. It has besides been pointed out by Semper (Reis. im Philip., vol. iii., p. 106) that the difference between an elasmognathous and an holognathous jaw is more apparent than real, since an equivalent to the quadrate plate, though not sufficiently solid to resist the action of caustic potash, exists in all *Helicidæ*.

JANELLA, Gray, 1850.

SYNONYMS.—*Athoracophus*, Gould, 1852; *Konophera*, Hutton, 1878; non *Janella*, Grateloup, 1838; *Pseudaneitea*, Cockerell, 1891.

DESCRIPTIONS.—Mrs. Gray's Figures of the Mollusca, vol. iv., p. 112; United States Exploring Expedition, xii., p. 1; Trans. N.Z. Inst., xiv., p. 158; Zeits. fur Zool., xv., p. 84, &c., &c.

OBS.—Fischer, whose lead in this matter has been generally followed, substitutes (Journ. de Conch., vol. xvi., p. 228) *Athoracophorus*, Gould, 1852, for *Janella*, Gray, 1850, on the plea that—(1) *Janella* was insufficiently characterized, (2) published without a Latin diagnosis, and (3) that it was preoccupied in 1838 by Grateloup. The first objection may fairly be met by considering that the figures published by Quoy and Gaimard, to which Gray referred, would have been a sufficient foundation for the genus without further explanation. The second obstacle to the recognition of *Janella* has no weight with naturalists of the present generation. The third difficulty is overcome by Fischer himself, who relegates *Janella*, Grateloup (Conchyl. foss. du Bassin de l'Adour, 4e memoire, p. 12) to the synonymy of *Niso*, Risso.* To such cases apply Rule X. of the Rules for Zoological Nomenclature, adopted by the British Association, sometimes called the Stricklandian Code, which runs as follows: "A name should be changed

* See also E. von Martens, Critical List of the Mollusca of New Zealand, 1873, p. 14.

which has before been proposed for some other genus in zoology or botany, or for some other species in the same genus, when still retained for such genus or species." The intricacies of this biological law have recently been discussed by several naturalists in the seventh and eighth volumes of the sixth series of the "Annals and Magazine of Natural History."

1. **J. bitentaculata,** Quoy and Gaimard, 1832.

Synonym.—*antipodarum*, Gray, 1853.

Illustrations.—Voyage de "l'Astrolabe," Moll., pl. xiii., figs. 1, 2 (from which are copied: Genera Recent Moll., pl. lxxx., fig. 5; Struct. and Syst. Conch., pl. ci., fig. 51; Figures Molluscous Animals, iv., pl. clxxx., fig. 15; Chenu's Man. Conch., f. 3498); Trans. Linn. Soc., xxii., pl. 66, figs. 1–3; and U.S. Expl. Exped., xii., pl. i., figs. 6, *a*, *b*, *c*.

Descriptions.—Voy. "Astrolabe," vol. ii., p. 149; Ann. Mag. Nat. Hist. (2), xii., p. 414; Proc. Z. S., 1853, p. 112; United States Exploring Expedition, vol. xii., p. 2; Zeitschrift fur Zoologie, xv., p. 84; New Zealand Mollusca, p. 27; Trans. N.Z. Inst., xvi., p. 206, &c.

Anatomy.—Trans. Linn. Soc., xxii., pl. 66, figs. 4–11; Trans. N.Z. Inst., xiv., pl. v., figs. 12–16: Reisė im Archd. Phil., iii., pl. xv., figs. 16, 17.

Habitat.—Tasman Bay, Wellington, Dunedin, Christchurch, and Greymouth, New Zealand.

Var. **papillata,** Hutton, 1879.

Descriptions.—Trans. N.Z. Inst., xi., p. 332; *op. cit.*, vol. xiv., p. 159; *op. cit.*, xvi., p. 206; Manual N.Z. Mollusca, p. 27.

Anatomy.—Trans. N.Z. Inst., xiv., pl. v., figs. 10, 11.

Habitat.—Wellington and Dunedin, New Zealand.

J. verrucosa, Von Martens, 1889.

Illustration.—Nova Acta der Ksl. Leop.-Carol. Deutschen Ak. der Naturforscher, Band liv., pl. iv., fig. 11.

Description.—*Op. cit.*, p. 77.

Anatomy.—*Op. cit.*, pl. iv., figs. 12–14.

Habitat.—New Zealand.

Var. **nigricans,** Von Martens, 1889. *Op. cit.*, p. 77.

Var. **fasciata,** Von Martens, 1889.* *Op. cit.*, p. 79.

Obs.—Probably this species is identical with *J. bitentaculata*, var. *papillata*.

* The name of this variety in "Nov. Acta" is *fuscata*, but Professor E. von Martens, in a letter dated the 5th April, 1892, writes to me that *fuscata* is a writing—or printer's—error, and that he called the variety *fasciata*, because it is (in spirits) pale yellowish-white, with several interrupted longitudinal lines of black.—H. Suter.

2. **J. marmorea**, Hutton, 1879.
ILLUSTRATION.—Trans. N.Z. Inst., xiv., pl. v., f. 1.
DESCRIPTIONS.—Trans. N.Z. Inst., xi., p. 332; *op. cit.*, xiv., p. 158; *op. cit.*, xvi., p. 206; Manual N.Z. Mollusca, p. 27.
ANATOMY.—Trans. N.Z. Inst., xiv., pl. v., figs. 2–9.
HABITAT.—Dunedin and Greymouth, New Zealand.

J. marmorata, Von Martens, 1889.
ILLUSTRATION.—Nova Acta der Ksl. Leop.-Carol. Deutschen Ak. der Naturforscher, Band liv., pl. iv., f. 3.
DESCRIPTION.—*Op. cit.*, p. 71.
ANATOMY.—*Op. cit.*, pl. iv., figs. 4–10.
HABITAT.—New Zealand.*
OBS.—Perhaps synonymous with *J. marmorea.*

Neojanella dubia, Cockerell, 1891.
DESCRIPTION.—Proc. Zool. Soc., 1891, p. 217.
OBS.—A questionable species and a still more questionable genus, founded upon a single shrunken and mutilated specimen, unaccompanied by figures or anatomical details. It probably belongs to the preceding species. One of the greatest defects in the prosecution of biological research is that any one whose presumption exceeds his ignorance should be enabled to thrust such stumbling-blocks as *Neojanella dubia* in the path of the honest investigator.

ANEITELLA, Cockerell, 1891.

DESCRIPTION.—Proc. Zool. Soc., 1891, p. 215.
OBS.—Possibly a distinct genus, but as yet insufficiently characterized.

3. **A. virgata**, E. A. Smith, 1884.
ILLUSTRATION.—Proc. Zool. Soc., 1884, pl. xxii., figs. 1, 1*a*.
DESCRIPTION.—*Op. cit.*, p. 262.
HABITAT.—Wild Island, Admiralty Archipelago.

ANEITEA, Gray, 1860.

SYNONYM.—*Triboniophorus*, Humbert, 1863.
DESCRIPTION.—Ann. Mag. Nat. Hist. (3), vi., p. 195; Mem. Soc. Phys. Hist. Nat. Genève, xvii., p. 119; Zeits. für Zool., xv., p. 84; Proc. Roy. Soc. Queensland, v., p. 168; Jahrbuch Deut. Malak. Gesell., i., p. 195, &c.

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* Professor E. von Martens also mentions in his letter that *Janella verrucosa* and *J. marmorata*, named by him and described by Dr. Simroth, were collected and brought to Germany from the Auckland Islands by Hermann Krone. In Trans. N.Z. Inst., vol. xvi., p. 206, the Auckland Islands (coll., H. Krone) are given as habitat of *J. bitentaculata* and *J. papillata.*—H. SUTER.

Obs.—An examination of spirit specimens misled Humbert into distinguishing *Triboniophorus* from *Aneitea* by the lack of a dorsal groove, obliterated in his examples.

4. **A. macdonaldi**, Gray, 1860.

Illustration.—Ann. Mag. Nat. Hist. (2), xviii., pl. iii., figs. 1 and 2.

Description.—*Op. cit.*, p. 38–41, and (3), vi., p. 196.

Anatomy.—*Op. cit.*, pl. iii., figs. 3–6, from which are copied Zeit. f. Zool., xv., pl. vi., figs. 12, 13.

Habitat.—Aneiteum, New Hebrides.

Obs.—The teeth and jaw are, as Fischer observes, not well shown in Dr. Macdonald's figures. The former were probably studied with too low a power, and the latter appears to have shrivelled before being sketched.

Mr. Cockerell has proposed (Proc. Z. S., 1891, p. 215, and Ann. Mag. Nat. Hist. (6), ix., p. 371) to disturb our nomenclature by transferring the name "*macdonaldi*" to a New Caledonian species, presumably *hirudo* or *modesta*, on the plea that Gray's types were New Caledonian specimens. Since Gray distinctly states that he applied the name "in recollection of the island where it was first discovered, and also of its first discoverer," I consider that he only incidentally alluded to the New Caledonian specimens, *which were not described*, and that he bestowed the name on the specimens figured and described by Dr. Macdonald. We may thus rigidly follow the path of justice and yet escape from the confusion in which Mr. Cockerell would involve us.

5. **A. graeffei**, Humbert, 1863.

Synonyms.—*kreffti*, Keferstein, 1865, and *schutei*, Keferstein, 1865.

Illustrations.—Mem. Soc. Phys. Hist. Nat. Genève, xvii., pl. xi., fig. 2 (3 figures); Zeits. fur Zoologie, xv., pl. vi., figs. 1–3; Verhandl. der k.-k. Zool. Bot. Ges., xx., pl. xi., fig. 1; Proc. Roy. Soc. Queensland, v., pl. vii. (2 figures).

Descriptions.—Mem. Soc. Phys. Hist. Nat. Gen., xvii., p. 120; Zeitschrift für Zool., xv., pp. 84, 85; Verhandl. der k.-k. Zool. Bot. Ges., xx., p. 844; Journ. d. Mus. Godeffroy, lxxii., p. 159; Trans. Roy. Soc. S. Australia, v., p. 49; P.L.S. N.S.W. (2), vi., p. 559; Proc. Roy. Soc. Queensland, v., p. 168, &c.

Anatomy.—Zeit. f. Zool., xv., pl. vi., figs. 4–11; *op. cit.*, pl. xxxiv., fig. 6; Verhandl. der k.-k. Zool. Bot. Ges., xx., pls. xi., xii., xiii.; Proc. Roy. Soc. Queensland, v., pls. vi. and vii.; Nova Acta der Ksl. Leop.-Carol. Deutschen Akademie der Naturforscher, liv., pl. iv., figs. 15–18.

Habitat.—New South Wales, Queensland, and Northern Territory.

I take this opportunity of describing the following splendid-colour variety.

Var. **rosea,** *var. nov.*

Entire animal coloured bright melon-pink. Summit of Mount Bellenden-Ker., N.Q. (K. Broadbent), and Proserpine River, N.Q. (C. W. de Bergh Birch).

6. **A. hirudo,** Fischer, 1868.

ILLUSTRATIONS.—Journ. de Conch., xvi., pl. xi., fig. 1; Faune Conch. Nouv. Caled., pt. ii., pl. i., fig. 2.

DESCRIPTIONS.—Journ. de Conch., xvi., p. 146; Faune Conch. Nouv. Caled., pt. ii., p. 12.

ANATOMY.—Journ. de Conch., xvi., pl. xi.; Manuel de Conch., fig. 262.

HABITAT.—Île Art and Noumea, New Caledonia.

7. **A. modesta,** Crosse and Fischer, 1870.

ILLUSTRATION.—Faune Conch. Nouv. Caledonie, pt. ii., pl. ii., fig. 1.

DESCRIPTIONS.—*Op. cit.*, pt. ii., p. 13; Journ. de Conch., xviii., p. 238.

HABITAT.—New Caledonia.

HYALIMAX, H. and A. Adams, 1855.

DESCRIPTIONS.—Genera of Recent Mollusca, ii., p. 219; Journ. de Conch., xv., p. 18; Land and F.-W. Mollusca of India, p. 55; Manuel de Conchyliologie, p. 491, &c.

8. **H. perlucidus,** Quoy and Gaimard, 1832.

ILLUSTRATION.—Voy. "Astrolabe," Moll., pl. xiii., figs. 10–12, from which are copied: Chenu, Manuel, figs. 3475, 3476; Struct. and Syst. Conch., pl. ci., fig. 49.

DESCRIPTION.—Voy. "Astrolabe," Zool., vol. ii., p. 146.

HABITAT.—Pouce Mountain, Mauritius.

9. **H. mauritianus,** Rang., 1827.

ILLUSTRATION.—Manuel de l'Histoire des Mollusques, pl. xiv., figs. 5–7.

DESCRIPTIONS.—Bulletin des Sciences Nat., x., p. 300; Melanges Conchyliologiques, p. 55; Journ. de Conch., xx., p. 203.

ANATOMY.—Journ. de Conch., xx., pp. 204, 205.

HABITAT.—Mauritius.

10. **H. maillardi,** Fischer, 1867.

ILLUSTRATION.—Journ. de Conch., xv., pl. x., fig. 5.

DESCRIPTION.—*Op. cit.*, p. 218.

ANATOMY.—*Op. cit.*, pl. x., figs. 6–9.

HABITAT.—Mauritius.

11. **H. reinhardi,** Morch., 1872.
DESCRIPTIONS.—Journ. de Conch., xx., p. 314; Vid. Medd., 1872, p. 21; Land and F.-W. Mollusca of India, p. 59.
HABITAT.—Pulo Panjang and Sambelong, Nicobar Islands.

12. **H. viridis,** Theobald, 1864.
DESCRIPTIONS.—Journ. Asiat. Soc. Bengal, 1864, p. 244; Land and F.-W. Moll. of India, p. 60.
HABITAT.—Arracan.

13. **H. andamanicus,** Godwin-Austen, 1882.
ILLUSTRATION.—Land and F.-W. Moll. of India, pl. xi., figs. 1–3.
DESCRIPTION.—*Op. cit.*, p. 57.
ANATOMY.—*Op. cit.*, p. xi., figs. 4–9.
HABITAT.—Port Blair, Andaman Islands.

Var. **punctulatus,** Cockerell, 1890.
DESCRIPTION.—Ann. Mag. Nat. Hist. (6), vol. vi., p. 389.
HABITAT.—Andamans.
OBS.—These latter three species constitute the sub-genus *Jarava*, Godwin-Austen, 1882.

14. **[Parmarion] kersteni,** Von Martens, 1869.
DESCRIPTION.—Reisen Ost-Africa (Van der Decken), vol. iii., p. 160.
ANATOMY.—Jahrbucher der Deutschen Malakozoologischen Gesellschaft, 1877, vol. iv., pp. 325–329, cuts 1, 2, and 3.
HABITAT.—(Mount Kilimanjaro ?) East Africa.
OBS.—As stated in the Zoological Record, Pfeiffer's account of the anatomy necessitates the removal of *kersteni* from *Parmarion* and its insertion in the *Janellidæ*.

ART. XIX.—*Synonymical Notes on New Zealand* Cicadidæ.

By G. V. HUDSON, F.E.S.

[*Read before the Wellington Philosophical Society, 7th December, 1892.*]

THE publication of my paper on the New Zealand *Cicadidæ*, read before this Society on the 23rd July, 1890, appears to have aroused Mr. W. L. Distant, who has, after having been furnished with another series of specimens, made the following corrections in the naming and classification of these insects. Had the first two or three consignments received attention, my paper would never have appeared in its present shape, and

these confusing corrections and alterations would have been obviated. I feel it necessary to make some little explanation in connection with this matter, as it would appear from Mr. Distant's remarks ("Annals and Magazine of Natural History," April, 1892, pages 313 and 326) that I have been guilty of "perfunctory and hasty work" in describing species as new which were already known. As a matter of fact, it is impossible for collectors in New Zealand to identify their captures amongst the lesser-known orders of insects except by the aid of European authorities, and in this instance I did not describe these *Cicadidæ* until I had made every effort to obtain correct information on the subject. Some years ago a well-known New Zealand naturalist advised me to describe anything I did not know as "new," leaving the European authors to make the necessary corrections in the synonymy which would naturally result. It is almost needless to say that I have not followed this advice, but have in all cases submitted the specimens to competent authorities, as I consider that the creation of synonyms in any branch of natural history is most undesirable.

The following are the alterations above referred to :—

(From "Annals and Magazine of Natural History," 1892, pp. 326, 327.)

Melampsalta muta, Fabr.

Cicada muta, Huds. (part). Trans. N.Z. Inst., xxiii., p. 51 (1890).

Cicada aprilina, Huds. *Ibid.*, p. 53 (1890).

Melampsalta angusta, Walker.

Cicada muta, Huds. (part). Trans. N.Z. Inst., xxiii., p. 51 (1890).

Melampsalta scutellaris, Walker.

Cicada tristis, Huds., *l.c.*, p. 52.

Melampsalta iolanthe, Huds.

Cicada iolanthe, Huds., *l.c.*, p. 53.

Melampsalta nervosa, Walk.

Cicada cassiope, Huds., *l.c.*, p. 54.

I do not for a moment question the accuracy of the above conclusions, except in the case of *Cicada aprilina,* Huds., which I firmly believe to be a good species. I have taken at least twenty specimens of this insect, and amongst all these I have not found one with the slightest tendency to vary in the direction of any of the other species, or, in fact, in any direction whatsoever. It is evidently, then, a "constant variety," and, if constancy of characters does not denote a species, I fear that we should find considerable difficulty in discriminating between "species" and "varieties" anywhere.

Art. XX.—*Note on an Ant-like Insect* (Betyla fulva, *Cameron*) *parasitic in the New Zealand Glowworm.*

By G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 14th September, 1892.*]

Plate IX.

During the early part of June a young friend of mine (Mr. Albert Norris) informed me that he had found some pupæ of the New Zealand glowworm (*Bolitophila luminosa*), attached to some rocks in the big gully of the Botanical Gardens, Wellington, which, from their shrivelled condition, appeared to have been killed by some parasitic insect. I at once examined one of these pupæ, and found that it had been destroyed by a species of *Hymenoptera*, apparently nearly allied to the family *Ichneumonidæ*, the members of which are so well known as parasites in the larvæ of the *Lepidoptera.* The pupa of the parasite was imbedded in a quantity of refuse matter in the centre of the unfortunate glowworm pupa. As usual with the *Hymenoptera,* a single specimen only was contained in each host. On the 21st June one of the parasites appeared in the perfect condition. It was apterous, and resembled in the closest possible manner a worker ant (Family *Formicidæ*). On a further examination, however, I found that the insect was really referable to the family *Proctotrupidæ.* Amongst many other remarkable parasitic species, this family includes the genus *Platygaster,* the minute members of which are parasitic on the Hessian fly (*Cecidomyia destructor*) and other highly injurious insects belonging to the same genus. On the 23rd June another parasite emerged. This specimen was furnished with ample wings, and is consequently the male.

Not being a specialist in the order *Hymenoptera,* I am unable to proceed further with the identification of this insect. I have therefore forwarded male and female specimens* to Mr. E. Saunders, of London, who will be able to speak with authority on the subject; and, should it transpire that the insect is not already known, I have asked Mr. Saunders to kindly allow me to publish his scientific description with these notes.

The discovery of this parasite adds another chapter to the already remarkable life-history of the New Zealand glowworm.

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* These specimens were described by the Rev. T. A. Marshall, under the name of *Tanyzonus bolitophilæ,* in the *Entomologist's Monthly Magazine* for November, 1892. Subsequently, however, Mr. Marshall ascertained that the female insect had been previously described by Mr. Cameron in the Memoirs of the Manchester Literary and Philosophical Society (4th series, vol. ii., 1889), under the name of *Betyla fulva.* The insect must consequently be known under that name in future.

ART. XXI.—*Descriptions of New Species of* Araneæ.

By A. T. URQUHART, Corr. Mem. Roy. Soc. of Tasmania.

[*Read before the Auckland Institute, 17th October, 1892.*]

Fam. DRASSIDÆ.

Gen. DRASSUS, Walck.

Drassus scitulus, sp. nov.

Fem.—Ceph.-th., long, 3·6; wide, 2·5. Abd., long, 3·1; wide, 2. Legs, 4, 1, 2, 3 = 10·3, 8·5, 7·9, 7·3 mm.

Cephalothorax ochraceous or tan-colour; dorsal aspect mostly covered by a large, brownish, leaf-like mark, whose serrated margins have a somewhat deeper shade; petiole extends from middle of caput to hind-central eyes; the broad lateral bands on cephalic part are confluent with the leaf-like figure; marginal band narrow, fuscous; thoracic groove reddish. Very sparingly clothed with fine light hairs. Oval, moderately compressed forwards; pars cephalica subquadrate, somewhat depressedly convex above; *clypeus* less than one-third depth of facial space; thoracic part slopes somewhat abruptly; groove well defined; caput and radial striæ fairly well marked; contour of profile ascends from stalk at an angle of 60°; caput curved, second half shows a more abrupt incline.

Eyes do not differ much in size; posterior row form a slightly procurved line; median pair on dark, oval spots, separated from each other by an eye's diameter; about that interval and a half from laterals; anterior row recurved, arch about as pronounced as hind-row, length exceeds space occupied by three eyes of posterior line, centrals posited on a slight elevation, smallest of eight, placed rather nearer to side-eyes than they are to one another—a space visibly shorter than their own breadth; laterals posited on low tubercles, divided by an interval fully equalling their own diameter.

Falces brownish-ochreous; sparingly haired; project well beyond plane of clypeus, stout, breadth equal to more than one-half length.

Maxillæ colour of falces; gradually dilated, round-pointed.

Labium deeper shade; oval, half length of maxillæ.

Sternum and legs concolorous, clouded round margins; broad-ovate.

Legs yellow-ochreous; femoral joints have four, patellar one, tibial and metatarsal two broken, deep olive-green annulations; sparingly furnished with fine hairs; spine armature—

first and second pairs, femora 2 or 3; tibiæ 2, 2, 2, 2; metatarsi 2, 2, 2; femoral joints of hind-pairs 3 or 4; tibial 2, 2, 2, two spines on outer and inner sides; 1, 1 on superior aspect; metatarsal joints about 18 spines; tarsal claws 6 teeth; scopula moderately developed.

Palpi and legs concolorous, rings evanescent.

Abdomen inversely-ovate; hairs yellowish, short, thinly interspersed; brownish-ochreous, specific pattern fuscous, somewhat intricate; basal fourth occupied by two parallel conduplicate figures whose inner ends are prolonged and deviate beyond the reddish impressed spots, terminate at a wide lanceolate mark, with somewhat tooth-like dilatations, enclosed within this figure are four acute chevrons, increasing in size, of the normal ground-colour; lateral margins exhibit a series of oval spots; ventral region sparingly spotted; spinners orange-ochreous. *Corpus vulvæ* represents a moderate elevation, occupied by two subcircular foveæ, divided by a wide septum nearly their equal in breadth.

The four examples that I have—three females and an immature male, which closely resembles them both in form and coloration—of this handsome little *Drassus* were captured by *Captain T. Broun* at the Hunua, near Auckland.

Gen. Clubiona, Walck.

Clubiona nitida, sp. nov.

Fem.—Ceph.-th., long, 3; wide, 2. Abd., long, 5; wide, 2·9. Legs, 4, 1, 2, 3=7·8, 6·5, 6, 5 mm.

Cephalothorax ochraceous, somewhat lightly clouded with dull olive-green, tolerably thickly clothed, erect, black, and close lying, pale-golden hairs, the latter have somewhat faint pinkish and bluish reflections; ovate, rather sharply constricted beyond coxæ of first legs; caput roundly truncated; height of *clypeus* scarcely equals diameter of a fore-centre-eye; thoracic groove short, well defined; profile-contour ascends from stalk at an angle of fully 60°, falls with a moderate incline to hind-row of eyes.

Eyes on dark rings; posterior row visibly procurved, distributed at nearly equal distances—space visibly surpassing diameter of a central eye; anterior row recurved, median pair dark, enclosed within a fuscous patch, separated by an interval equalling three-fourths their breadth; lateral pairs have the pearl-grey lustre of hind-centrals, exceed them in size by about one-third; sensibly smaller than anterior median pair; posited on slight eminences, quite their diameter apart.

Falces orange-ochreous; base projects somewhat abruptly beyond plane of clypeus.

Maxillæ brownish-ochreous; basal half turgid, enlarged at insertion of palpus; second half plainly constricted, some-

what abruptly dilated, round-pointed ; curve over *labium*, which has a reddish hue ; oval, three-fourths length of maxillæ.

Sternum has the ochraceous tone of coxæ ; acute-oval.

Legs brownish-yellow ; tibial joints of first and second pairs deeper shade ; metatarsi and tarsi red-chestnut ; hairs black, erect, moderately thick ; thighs well armed with bristle-like spines ; tibiæ of first and second 1, 1 inferior aspect ; metatarsi of second legs 2 spines near base ; of first, apparently only 1 ; metatarsal and tarsal scopula well developed ; spines on posterior pairs stronger and more numerous.

Palpi resemble legs in colour and armature.

Abdomen elongate-oviform, base somewhat squarely truncated, projects a dense patch of black hairs ; fairly well clothed with erect black, and adpressed, fine golden hairs reflecting pinkish-blue shades ; integument slaty-grey, bluish metallic reflections ; specific pattern on anterior half consists of an acutely-oval figure nearly enclosed by dusky, undulating lines ; posterior half occupied by a large broad-oval, dusky spot, almost enclosing an acute-crenate, lanceolate mark of the normal ground-colour. Ventral region of a duller shade ; spinners yellowish. *Vulva* bright-ochreous, shaded with chestnut ; represents a rather large, subpyriform depression, bounded by a turgid costa ; area intersected by a narrow septum, which is somewhat dilated between the superior pair of foveæ ; inferior pair occur at the fore-end, and are separated from septum by an interval about equal to its own breadth.

Hunua. *Capt. T. Brown.*

Fam. AGELENIDÆ.

Gen. TEGENARIA, Latr.

Tegenaria livoris, sp. nov.

Mas.—Ceph.-th., long, 3 ; wide, 2. Abd., long, 3·1 ; wide, 2. Legs, 1, 2, 4, 3 = 14·5, 12·2, 9·8, 8·4 mm.

Cephalothorax ochraceous, speckled over cephalic region and between radiating depressions with minute olivaceous dots ; medial streak slender ; sparingly clothed, mostly over caput, with short, whitish hairs ; oval ; moderately compressed beyond coxæ of first pair of legs ; pars cephalica roundly truncated ; height of *clypeus* barely equals diameter of a fore-central eye ; thoracic groove red, sharp ; radial striæ well defined ; contour of profile ascends from petiole at an angle of 55°, falls with a perceptible curve to frontal margin.

Posterior row of *eyes* procurved, do not differ essentially in size, distributed at nearly equal distances ; centrals placed on dark, oval spots ; represent with fore-pair a trapezoid narrowest in front ; anterior row nearly straight ; median pair smallest of eight by one-third, divided by an interval fully

equal to their radius; laterals posited, about one-third of an eye's breadth apart, on strongish, dark tubercular eminences.

Falces have a rich, glossy, brownish-ochreous tone; basal two-thirds of somewhat even breadth, fore-third tapers rather abruptly, directed outwards; project prominently forwards; much stouter than thigh of a fore-leg.

Maxillæ deep-ochreous, lightly clouded; well developed, gradually dilated, somewhat acutely pointed; visibly inclined towards *labium*, which has a darker shade; oval, truncated; more than half length of maxillæ.

Legs light yellow-ochreous; pars humeralis cylindrical, arcuated; one-third longer than the two following articles together; armed with three spines; cubital joint subovate; projects two bristles; radial joint chestnut-colour; stouter and somewhat longer than former article; prolonged beneath; a plainly visible, margined sulcus divides the latter extension from a stout, somewhat forward-curved process on posterior side; projects a group of long bristles from superior surface; pars digitalis about equal in length to the three former articles together; coloration of lamina approximates to tortoise-shell; fairly well furnished with fineish hairs; ovate, inner margin bordered with a wide, deeply-grooved, chestnut-coloured costa; palpus-like extension barely as long as ovate part; genital bulb bears a mollusc-like aspect; of a dull metallic-white, lightly suffused and streaked with slate-colour; depressedly convex; scarcely rises to same plane as borders of lamina; terminates in two subspiral, fuscous apophyses; anterior half of the inner and largest, which springs from near the centre of bulb, tapers rapidly.

Abdomen oviform; pale-brown, clouded with light slate-colour; moderately clothed with light, adpressed, and bristle-like black hairs.

Single example, captured by *Capt. T. Broun*, Maketu Bush.

Fam. THERIDIIDÆ.

Gen. Steatoda, Sund.

Steatoda nubilosa, sp. nov.

Fem.—Ceph.-th., long, 1. Abd., long, 1·8. Legs, 4, 1, 2, 3 =2·8, 2·5, 2·3, 2·2 mm.

Cephalothorax brownish-yellow, streaked with olive-brown; occiput exhibits a fuscous-olive, diamond-shaped figure, connected with lateral eyes by arcuated lines; marginal border similar shade; radiating stripes not continuous, resolved into fine dots; glabrous; clathrate; broad-ovate, sides rather abruptly dilated; pars cephalica prominent, projects slightly over *clypeus*, which is inclined sensibly forwards; height plainly exceeds one-half facial space; indentation on posterior

slope rather large and deep (apparently natural); normal grooves slight; profile-line ascends from petiole at an angle of 50° to limit of caput; plainly arched across cephalic part.

Eyes large, do not differ much in size; posterior row moderately procurved; centrals a little more distant from laterals than they are from each other—an interval equal to quite an eye's radius; anterior row form a tolerably strong, recurved line; median pair dark, smallest of eight, close to side-eyes, form with hind-pair a quadrilateral figure rather longer than broad; laterals slightly elevated, contiguous.

Falces yellow-ochreous, display wide, olive-green, central bands connected with base by broad tapering lateral stripes; conoid, moderately slender, project forwards; barely one-fourth longer than clypeus; fangs slight, more than half length of falx; no teeth.

Maxillæ tapering, inclined towards each other. *Labium* large, triangular, about as wide as long; organs light chocolate-brown, pale slate-coloured apices.

Sternum fuscous; ovate, rather prominently convex.

Legs bright ochraceous-orange; fore-part of femoral and tibial joints dappled with olive-green; somewhat sparsely armed with rather coarse hairs; few bristles; tolerably stout. Superior tarsal claws—first pair, rather strong, 5 stoutish teeth; inferior claw has apparently only 1 tooth.

Palpi and legs concolorous; moderately haired.

Abdomen oviform, nearly as wide as long; hairs light, somewhat sparse; ground-colour stone-brown, figured with fuscous-black clouds, and metallic-white spots, latter occur chiefly over dorsal region. *Corpus vulvæ* yellow-brown, fuscous clouds; moderately elevated; exhibits two sub-circular, lake-brown foveæ, separated by a narrow septum; superior margin developed into a long, transverse, tolerably wide, membranous, incurved lip, pale-grey above, passing into olive-green beneath.

A single specimen of this species was contained in *Capt. T. Broun's* collection from Maketu, near Auckland.

Gen. STEGOSOMA, Cambr.

Stegosoma lacunosa, sp. nov.

Fem.—Ceph.-th., long., 1. Abd., long, 2; broad, 2; deep, 1·8. Legs, 4, 1, 2, 3: fourth, 2·2mm.; 1–2–3 do not differ much in length.

Cephalothorax brownish-yellow, olivaceous tinge, passing into reddish-brown on fore-part; lateral border olive-brown; caput moderately clothed with strong, light hairs; broad-ovate; pars cephalica elevated, prominent, limited by a well-defined transverse groove; *clypeus* projecting, deeply impressed, depth

equal to more than half facial space; pars thoracica depressedly convex, exhibits a very observable circular fovea on each lateral slope; striæ fairly marked; profile-contour rises moderately to verge of occiput, from thence dips abruptly into caput groove, slopes to petiole at an angle of 40°.

Four central *eyes* large, placed on dark rings, form a quadrilateral figure; anterior pair dark, about one-third larger than hind-pair; posited rather closer to each other than they are to dorsal eyes—an interval about equal to space separating the latter pair; anterior row strongly recurved; posterior line sensibly so, distributed at nearly equal distances; the lesser interval which divides the centrals surpasses an eye's diameter by one-half; laterals as large as centre-eyes of hind row, seated on a low, dark eminence, contiguous.

Falces yellow-brown; conical, slender, vertical.

Maxillæ orange-yellow, passing into a darker tone at base; transversely rugose; spathulate, curve over *labium*, which has a similar shade; semicircular, truncated, width somewhat exceeds length.

Sternum chestnut-brown; cordate; strongly rugose; projects coarse yellowish hairs.

Legs yellowish-orange; more or less pronounced annulations of a purple-brown shade at articulation of joints; hairs yellowish, sparse; few slender bristles. Legs do not differ much in length or strength.

Palpi shade darker than legs, armature similar.

Abdomen large, projects well over base of cephalothorax; of a rather quadrate form; dorsal aspect aplanate, plainly divergent to posterior incline; each corner of the trapezoidal dorsum projects a strong tubercle—hind-pair long, stout, conical, round-pointed, directed backwards and outwards; fore-pair about one-third shorter, equally stout, project outwards, inclined forwards; two similar but much smaller tubercular prominences occur on each lateral slope; posterior pair form a transverse line with the hind superior tubercles, and the fore-pair are placed midway between the latter and the anterior protuberances; integument very closely pitted with well-defined, deep foveæ; projecting from within are short, golden hairs; nine dark, impressed spots enclose a subcircular space on dorsum; similar dots occur in lines round the somewhat abrupt sides; ground-colour pale brownish-yellow, suffused and clouded with lake-brown; latter shade approximating to a deeper tone on posterior half; moderately spotted and streaked with the yellowish hue; a short, creamy-coloured stripe curves round base. *Vulva* represents a simple, transverse, narrow, fuscous, lip-like projection.

An immature female, apparently of the same species, was contained in *Capt. T. Broun's* collection from the Hunua,

near Auckland; the type example was taken by myself in the bush at Ohaupo.

Stegosoma excussa, sp. nov.

Fem.—Ceph.-th., long, 1. Abd., long, 2·4; wide, 2·2 mm. Legs short, do not differ much in length or strength; 4, 1, 2, 3.

Cephalothorax dark mahogany-brown; pitted with foveæ; hairs rather coarse; broad-ovate, lateral constriction at caput moderate; cephalic part roundly truncated; *clypeus* impressed, height perceptibly surpasses depth of eye-area; occiput turgid, sharply divided from the pars thoracica by a transverse groove; latter part exhibits a deep indentation on posterior slope; profile-contour represents a semicircular curve or hump at occiput, from thence slopes moderately with a slight arch to stalk.

Eyes large, no very perceptible difference in size; posterior row sensibly recurved, median pair placed rather closer to side-eyes than they are to each other—about an eye's diameter; anterior row represents a more pronounced curve; centre-pair dark, largest of eight; form with hind median pair a nearly quadrate figure, posterior eyes occupying the greater space; lateral pairs contiguous.

Falces yellowish, suffused with ochraceous-lake; linear-conical, vertical.

Maxillæ dilated, obtusely pointed, inclined over *labium*, which is large, turgid, subquadrate, rather wider than long; organs orange-yellow, clouded with brown-pink.

Sternum yellowish brown-pink; cordate, deeply pocked.

Legs light-ochraceous, greenish reflections; annulations reddish-brown; armature normal.

Palpi reddish-chestnut; short, slender.

Abdomen broad-ovate in outline; closely and deeply pitted, foveæ project short, light hairs; a stout tubercular process rises from each corner of the depressed dorsal area; hind-pair about one-third longer than fore-pair, roundly-conical, directed backwards with a slight outward incline; anterior pair depressedly conical, inclined somewhat backwards and outwards; slope from hind-tubercles to spinners moderate, traversed by three folds; most of the dorsal region has an orange-ochreous shade, figured with dark-brown stripes or patches; four pairs of spots occur on posterior slope; lateral margin suffused with fuscous-purple; encircled by a cream-coloured, purple-spotted, undulating band; a circle of impressed spots occur in the middle of the dorsal area. Ventral region exhibits two orange-yellow bands. *Corpus vulvæ* black-brown; represented by a transverse, narrow, lip-like projection.

Single specimen, captured in the bush, Ohaupo. *A. T. U.*

Fam. TETRAGNATHIDÆ.

Gen. Tetragnatha, Latr.

Tetragnatha tenella, sp. nov.

Mas.—Ceph.-th., long, 3; wide, 2. Abd., long, 7·3; wide, 1·3. Legs, 1, 2, 4, 3 = 33, 28, 24, 16·8 mm.

Cephalothorax delicate pea-green; clothed with very fine adpressed light and erect black hairs; pars cephalica depressedly convex, roundly truncated; lateral index equals facial; depth of *clypeus* equal to interval dividing the fore-centre eyes; pars thoracica depressed, moderately dilated; fovea deep, longitudinal; radial and caput striæ somewhat shallow; profile-line almost horizontal, dips across first half of caput.

Posterior row of *eyes* slightly recurved, distributed at about equal distances; centre-pair intersect acute-oval black spots; anterior row, viewed from above, sensibly procurved; median pair black, on black rings, much the smallest of eight; separated by fully an eye's interval; laterals about one-fourth larger than posterior median pair, have their pearly lustre, encircled by lake-black rings; rather more than their diameter apart; anterior pair posited on somewhat prominent tubercles, projecting forwards and outwards.

Falces normal green; subconical, anterior half inclined outwards, project rather prominently forwards; somewhat stouter than the femur of a fore-leg.

Maxillæ pale pea-green, fore-half mottled with lake; basal half somewhat gibbous, enlarged at insertion of palpus; distal half of somewhat even breadth, pointed; inclined somewhat towards each other.

Labium pea-green; linear-oval, apex emarginate.

Sternum similar tone; oval.

Legs have the normal pea-green shade; slender, do not differ much in strength; hairs very sparse; femoral, tibial and metatarsal joints fairly well armed with light-brown slender spines; long on two latter articles; patellæ project two short bristles; superior tarsal claws long, curved at extremity; outer claw about 25, inner about 40 teeth increasing gradually in strength; inferior claw sharply bent, 2 long, nearly equal, backward-curved teeth.

Palpi and legs concolorous; tolerably stout; pars humeralis = 3mm., as long as tarsus of a fore-leg; of somewhat even breadth, arcuated; armed with 4 or more spines; pars cubitalis short, somewhat campanulate; bristle at apex; radial joint 2mm. in length, cylindrical, somewhat incrassated at base; extremity on outer side subfree, triangular, margin beaded; contiguous to latter projection is a stout, fuscous-tipped, forward-curved process, furnished with a cilia-like crest

on the concave side; 6 long bristle-like spines; pars digitalis 2·5mm. in length; lamina ovate, 0·8mm. long; prolonged in a clavate-cylindrical form; latter extension rather stouter than tarsus of a fore-leg; armed with 6 spines, 3 strongest occur on ovate portion; bulbus lake-brown; inversely ovate, moderately turgid, extremity somewhat convoluted; traversed from inner fore-end to base on outer side by an undulating callus; projecting from anterior half are two horn-like apophyses, curved towards each other; slender half lake-brown; inner and anterior convolution drawn out into a rather large, subtriangular process, projecting outwards between the apophyses; genital bulb exhibits beneath, on posterior side, a series of cilia-like ridges.

Abdomen has the uniform delicate, pea-green tone; cylindrical, base truncated; moderately furnished with fine pale and dusky hairs.

The apparently immature *females*, taken at the same time, do not differ essentially in form or coloration from the male example.

The described specimens of this delicate species were captured in the forest on Pirongia Mountain; and I have taken examples in the Waiorongomai Gorge, Te Aroha; Mount Egmont, Taranaki.

Fam. EPEIRIDÆ.

Gen. EPEIRA, Walck.

Epeira angusticlava, sp. nov.

Fem.—Ceph.-th., long, 3; broad, 2·5. Abd., long, 5·8; broad, 5. Legs, 1, 2, 4, 3=13·5, 12, 11·8, 7 mm.

Cephalothorax burnt-sienna colour; sparingly clothed with adpressed, whitish hairs; cephalic part convex, lateral index equal to fully two-thirds of facial; ocular eminence tolerably prominent; height of *clypeus* equals space dividing anterior centre-eyes; thoracic part somewhat depressed above, sides rounded; fovea oval, deep; normal grooves moderate; contour of profile represents a somewhat even curve.

Posterior and anterior rows of *eyes* moderately recurved; four centrals do not differ essentially in size, form a trapezoid rather wider in front than long; fore-pair about an eye's breadth and a half apart; hind-pair tinged with lake, divided by an interval equal to their diameter, removed scarcely their space and one-half from side-eyes; laterals visibly the smallest of eight, less than their radius apart, placed on low eminences.

Falces fulvous; conical, vertical, project well beyond plane of clypeus, about as stout as the femur of a second leg.

Maxillæ pale greenish-brown, clouded with a deeper shade;

rather longer than broad, obtusely pointed, inclined over *labium*, which has a similar colour, length nearly equal to breadth, round-pointed.

Sternum orange-ochreous, red-chestnut clouds round margins; cordate; eminences opposite coxæ.

Legs ochraceous, thighs suffused with lake, red-chestnut annulations on fore-end of tibial, metatarsal, and tarsal joints; hairs fine, yellowish, somewhat sparse; spines yellowish, moderately numerous.

Palpi brownish-yellow, indications of annuli; armature similar to legs.

Abdomen angular-ovate, moderately convex above; ground-colour creamy-brown, basal margin fuscous-green; folium broad-lanceolate, anterior border lake-colour, sides defined by four pairs of blackish, irregular oval spots, decreasing in size, subtouching; central area traversed by four lake, undulating bands, whose extremities are contiguous to the above-mentioned spots; the four impressed dots are enclosed within the two anterior bands; lateral margins exhibit a series of vertical, lake-brown, acute, V-shaped marks. Ventral region suffused with lake; shield brownish, evanescent. *Vulva* represents a broad, moderately-tapering, dark amber-coloured, transversely-wrinkled scape, fore-end rapidly constricted into a short-stalked stylus, apex broad-calceolate; scapus vulvæ laterally bordered by well-developed, cylindrical, fuscous lobes; enveloped on outer side by close-fitting cutaneous folds of a darker shade.

Single example. Taupiri Mountain, Waikato. *A. T. U.*

Epeira æstiva, sp. nov.

Fem.—Ceph.-th., long, 4·8; wide, 4. Abd., long, 14; wide, 14. Legs, 1–2, 4, 3 = 16, 14, 9 mm.

Cephalothorax light-ochreous; hairs whitish, somewhat sparse; length equal to patella + tibia of a fourth leg; pars cephalica convex, lateral index fully equal to two-thirds of facial; ocular prominence rather low; depth of *clypeus* equal to interspace between fore-central eyes; pars thoracica convex, dilated; fovea deep; caput and radial striæ fairly well defined; profile-contour somewhat prominently arched, incline across occiput nearly as abrupt as posterior.

Eyes of tolerable and nearly equal size, encircled by narrow dark rings, form two moderately-prominent recurved rows; four centrals represent a trapezoid a trifle longer than wide in front; fore-pair sensibly the largest of eight, separated from one another by scarcely an eye's breadth and a half; visibly less than that distance from hind-pair, which are divided by an interval almost equalling their own diameter; about their space and one-half from side-eyes; laterals smallest

of set, posited obliquely on a very slight elevation; less than their radius apart.

Falces pale yellow-ochreous; conical, vertical, gibbous at base in front, nearly as stout as first quarter of femur.

Maxillæ light-ochreous, stained; rather longer than broad, dilated, obtusely pointed, inclined towards each other.

Labium brownish-yellow, apex pale; perceptibly wider than long, round-pointed.

Sternum brownish-ochreous, fuscous clouds; cordate; eminences slight.

Legs brownish-ochreous, femora suffused with lake; hairs short, sparse, whitish; tolerably well armed with yellowish, dark-based spines; legs somewhat slender; first and second pairs of about equal length and strength.

Palpi yellowish, green tinge; slender; armed with light hairs and spines.

Abdomen triangular-ovate, depressedly convex; ground-pattern formed by a series of confluent, large, cream-coloured flecks, stained with light-brown, indications of purple margins; folium purple cream-colour, spotted with purple; leaf-like, acute-crenate; petiole and midrib formed by a series of elongated spots of the normal ground-shades, placed transversely on posterior half; the four impressed spots occur within four rather large, subpyriform marks. Ventral surface suffused with bright-lake, bordered by broad, irregular, greenish-black bands, which encroach into the basal region; shield similar shade, triangular. *Corpus vulvæ* glossy, fuscous-black; projecting, base elliptical, transverse, about twice as broad as long, wrinkled; scape brownish; moderately wide, of somewhat even breadth, flat, transversely rugose; apex circular, ladle-like; intersects and projects beyond two well-developed convoluted lobes.

Two specimens of this handsome, pale-tinted species were captured on Taupiri Mountain. *A. T. U.*

Epeirana viridana, sp. nov.

Fem.—Ceph.-th., long, 3·2; wide, 2·8. Abd., long, 5; wide, 4. Legs, 1, 2, 4, 3 = 14·8, 13, 11, 8 mm.

Cephalothorax light ochraceous-brown; cephalic part lightly suffused with bright-green; displays a large, fuscous heart- or spade-shaped spot over foveal indentation; the brown streaks that define caput grooves are bent to an obtuse angle at limit of caput, and form a continuous line to region of fovea; hairs adpressed, light, somewhat sparse; clathrate; pars cephalica moderately convex, eye-prominence projects well over *clypeus*, whose depth fully equals the interspace between the fore-central eyes; lateral index equals two-thirds of facial; pars thoracica convex, well rounded; fovea tole-

rably deep, oval; radial striæ faint; caput grooves more defined; contour of profile slopes slightly across cephalic part, dips moderately to stalk.

Eyes do not differ much in size, on dark rings; fore- and hind-row form two rather prominently recurved lines; anterior centrals largest of eight, form with hind-pair a trapezoid widest in front; posterior centrals closer to one another—visibly more than an eye's breadth—than they are to fore-pair; rather more than their space from side-eyes; laterals smallest of eight, posited obliquely, nearly the diameter of a posterior eye, which visibly the smallest, apart; fore-tubercle strongish, cup-shape.

Falces dull olive-yellow, traversed by a wide, olive-green band; subconical, vertical, project well beyond plane of clypeus; length fully equals the pars digitalis of palpus; as stout as femur of third leg.

Maxillæ dull brownish-yellow, greenish tone; rather longer than wide, moderately dilated, obtusely pointed.

Labium dark chocolate-brown, apex pale-slate.

Sternum brownish-drab, passing into dark-brown round margins.

Legs: Femora light brownish-yellow, marked with broken, fuscous-black annulations; patellæ, tibiæ, metatarsi and tarsi suffused with bright pea-green. Superior tarsal claws—first pair, 10 teeth; inferior, 2 close teeth.

Palpi colour and armature of legs; palpal claw evenly curved, 9 comb-teeth increasing in length.

Abdomen ovate, depressedly convex above; hairs yellowish, short, rather sparse; armed with spine-like bristles resembling leg-spines; integument light brownish-yellow, well suffused with bright pea-green; base on either side of the pea-green, buff-margined, subtriangular petiole of folium, fuscous-black; folium moderately wide, tapers gradually; dusky outlines, lightly stained with brown; basal end pinkish-creamy colour, studded with reddish spots; between the latter patch and anus six pairs of projections occur; three anterior much the largest, somewhat comma-shaped, up-curved, velvety fuscous-black; interrupted T-shaped marks of similar colour in line with fore-pair; three posterior pairs angular, greenish. Superior and larger portions of lateral margins, which have the greenish tone of dorsal aspect, are bordered by blackish, undulating lines; inferior parts yellowish-brown, marked with ill-defined, longitudinal streaks. Ventral shield semicircular, anterior end truncated; olive-brown, lateral borders fuscous-black; partially traversed, midway, by two creamy-coloured, somewhat pyriform marks. *Corpus vulvæ* ochraceous, passing into fuscous-purple on fore-aspect of the subglobose part; rests on a pale-brownish elevation; viewed from above, the genital

organ represents a transverse oval, basin-like projection, disclosing within two red-lake, pyriform foveæ, separated by a broad, triangular septum. A front view shows that the posterior half of corpus is rapidly constricted beneath the basin-like projection, tapering to extremity of the above-mentioned elevation; a yellowish, moderately wide, acute sinus—a continuation of the septum—intersects the dark rim and terminates above the rima genitalis. Scapus vulvæ yellowish, large, rather broad and flat, shows well-developed transverse wrinkles; apex dilated, rounded, depressed, somewhat spoon-shaped, curves backwards beyond margin.

Two examples, Taupiri Mountain. *A. T. U.*

Epeira munda, sp. nov.

Fem.—Ceph.-th., long, 2; wide, 1·4. Abd., long, 3·8; wide, 3. Legs, 1, 2, 4, 3 = 8·6, 6·5, 6, 4 mm.

Cephalothorax yellowish-olive, reddish cloud over caput; sides and radiating depressions olive-green; hairs white, sparse; pars cephalica convex, frontal index scarcely exceeds lateral; ocular prominence low; height of *clypeus* equals diameter of a fore-central eye; pars thoracica well rounded, sides fall somewhat steeply; normal grooves fairly well defined; profile-line ascends from stalk to the thoracic junction at an angle of 45°, slopes rather prominently over occiput.

Eyes on dusky spots, distributed in two recurved rows; four centrals of about equal size, form a trapezoid widest in front; posterior pair barely an eye's breadth apart; somewhat more remote from anterior pair; laterals about one-third smaller than centre-eyes, posited on a low, fuscous, tubercular eminence; separated by an interval fully equal to one-fourth their diameter.

Falces yellow-brown, clouded with olive-green; conical, vertical, base projects abruptly beyond plane of clypeus; about as stout as the femur of second leg.

Maxillæ greenish-yellow, base fuscous-green; dilated, pointed.

Labium coloration of maxillæ; width somewhat surpasses length, pointed.

Sternum fuscous, medial stripe broad, yellowish-olive; cordate; eminences opposite coxæ.

Legs light yellow-brown, fore-third of femora dark-brown; tibiæ and metatarsi marked with three olive-brown annulations; hairs light-brown, somewhat sparse; spines black, rather slight and long, irregularly distributed, moderately numerous.

Palpi resemble legs in colour and armature.

Abdomen angular-ovate; sparingly clothed with fine, light hairs; integument brownish-drab, clouded with soft dark-brown, dotted with more or less obscure lake spots; folium

extends over dorsal aspect, broad-lanceolate or spade-shape; petiole reaches from hind-pair (third pair) of impressed spots to spinners; light yellowish-olive, dappled with a deeper shade, suffused with cream-coloured intricate spots and lines, centred or bordered with dull lake-brown; apex and margin creamy-white, few reddish spots; ventral region light olive-brown; shield olive-brown, displays two yellowish spots. *Vulva* pale amber-colour; lateral extensions of corpus represent two large, semi-oval, rapidly bent, wing-like expansions, bordered by a deep costa; scapus spoon-shape, moderately long, stout, springs from between the involute basal extremity of wings, which exhibit a conspicuous dark spot.

Single specimen, Taupiri Mountain. *A. T. U.*

Var. **inversa**, var. nov.

Coloration of *cephalothorax* and *legs* does not differ very essentially from that of the type form.

Abdomen light yellowish-olive, flecked with greenish cream-coloured spots of irregular shape and size; traversed by about five dusky-olive bands, which gradually fade into the ground-colour; the folium differs both in form and position from the dorsal figure of the typical example; it is of an acute-lanceolate shape, the point, which is considerably drawn out, reaches to anus; petiole short, curves round base of abdomen; folium has the normal ground-shade, spots coalesce more or less into irregular-shaped patches; base and petiole bordered with cream-colour, stained with lake; outline defined by five pairs of soft-brown oval spots.

Single example, from the same locality. *A. T. U.*

Epeira albo-lineata, sp. nov.

Fem.—Ceph.-th., long, 3; broad, 2. Abd., long, 4; broad, 4. Legs, 1, 2, 4, 3 = 10, 9, 6·5, 4·6 mm.

Cephalothorax brownish-yellow; cephalic region lightly suffused with brown-lake; a dilated, chrome-yellow, V-shaped mark extends forwards from limit of caput; fairly well clothed with silky, whitish, adpressed hairs; somewhat depressed; outline oval; lateral constriction at caput moderate; ocular eminence not very prominent; facial index scarcely surpasses lateral by one-fourth; height of *clypeus* exceeds diameter of a fore-centre eye; thoracic groove longitudinal; striæ rather slightly defined; profile-contour represents a moderately prominent arch.

Fore- and hind-row of *eyes* somewhat evenly recurved; four centrals form a subquadrate figure; posterior pair about one-third larger than anterior, separated from them by a space visibly shorter than their own diameter, plainly more than that interval from each other; laterals rather the smallest of

eight, divided by fully an eye's radius; seated on moderately-developed tubercular prominences.

Falces pale-ochreous; conical, vertical, nearly as stout as thigh of a fore-leg.

Maxillæ pale slaty-brown; rather longer than wide, round-pointed.

Labium light slate-colour; perceptibly wider than long, roundly pointed.

Sternum brownish, clouded between median streak and eminences.

Legs light brownish-yellow; femora, especially of fore-pairs, stained with lake; remaining joints reflect an olive tinge; patellæ spotted; tibiæ, metatarsi, and tarsi marked with irregular, lake or olive-green annulations; somewhat sparingly furnished with whitish hairs; spines yellowish.

Palpi pale-brown, stained with lake, semi-pellucid; tolerably stout, armed with light hairs and spines.

Abdomen triangular-ovate; humeral tubercles moderately developed; ground-colour light yellow-brown, approximating to pale slaty-brown about tubercular region; closely flecked with small purple-brown dots, stained with fuscous-green; dorsal band broad, margins irregular, pale greenish-yellow, suffused with creamy-white, spotted with small lake-brown dots. Ventral surface yellow-brown, clouded with olive-green. *Corpus vulvæ* brownish amber-colour, green reflections; reniform, turgid, depressed; superior margin, above the rima genitalis, exhibits two elongate, transverse foveæ, intersected by a moderately-wide septum; scapus vulvæ pale yellowish-brown, curves somewhat closely over corpus, of even breadth, transversely rugose, apex large, circular, ladle-shape.

Single example, captured in the bush near Ohaupo. *A. T. U.*

Epeira blattea, sp. nov.

Mas.—Ceph.-th., long, 4·2; wide, 3·5. Abd., long, 4·2; wide, 4. Legs, 1, 2, 4, 3 = 17·5, 15, 12, 8·7. mm.

Cephalothorax brownish-fulvous, lightly clouded with red-lake, speckled with olive-green; latter tone predominates about posterior incline and lateral margins of caput; depressed, sides well rounded, sharply constricted forwards; lateral index equal to about three-fourths facial; thorax impressed by a large, quadrangular indentation, conspicuous within it is the long, dark thoracic groove; normal striæ ill-defined; profile-contour represents an almost horizontal line to posterior incline, which is slight.

Eyes rather small, nearly equal in size, encircled by black rings; form two prominently-recurved lines; posterior centrals divided by an interval plainly exceeding an eye's

breadth; anterior pair separated by an interval nearly equal to space occupied by hind-pair, form with them a trapezoid wider in front than long; laterals smallest of eight, posited obliquely, about an eye's diameter apart, on well-developed projections.

Falces light-brown, approximating to olive-green; slender, plainly arcuated, convexities directed towards each other, inclined inwards.

Maxillæ pale greenish-brown, base mottled with olive-green; rather short, gradually dilated, rounded.

Labium darker than maxillæ; about one-fourth wider than long, round-pointed.

Sternum greenish-fulvous, clouded with deep olive-green; cordate.

Legs fulvous, reflecting reddish and olive-green tints; thighs marked beneath with three broken olive-green annuli; indications of ochraceous or green rings on tibial and metatarsal joints; hairs whitish, sparse; spines moderately long; light-brown, base dark; tibiæ of first and second pairs well armed along second half, inner side.

Palpi: Humeral and cubital joints have the tints and reflections of legs; former article of somewhat even thickness; pars cubitalis, viewed from above, ovate; projects from extremity two strong bristles; radial joint dense olive-green; strongly developed on inner side, represents a vertical segment of a circle, pointed below; projects forwards, at a right angle, from the more tumid superior end a yellowish, membranous, dilated, bicornate process; two dark ocelli occur contiguous to border; springing from margin above the latter spots is a wide organ, whose somewhat rapidly compressed fore-half extends just beyond the light process above it; lamina fulvous, densely clouded with blackish-green; sparingly haired; broad-ovate, inner side deeply impressed, projects forwards well above bulb; base produced on outer side into a dark mahogany-coloured, up-curved process of the normal form; outer shell of genital bulb somewhat pyriform or subdiscoid, consists of three lobes or cutaneous folds; upper and lower bright straw-colour; central and somewhat more tumid lobe chestnut; lower lobe much the largest, upper rather the smallest of the set. A front view of bulbus discloses, on inner side, a yellowish, elongated, gradually-dilated, bifid membrane, whose inner extremity is truncated and drawn out into an acute process; contained between the above-mentioned processes is a dark, mahogany-coloured, crumpled lobe, prolonged into a moderately wide, emarginate appendage.

Abdomen triangular-ovate, depressed above; humeral tubercles fairly well developed. Ground-colour whitish, faint-purple tint, closely flecked with purple-lake dots, which

are confluent about lateral margins; fore-end of folium evanescent; tapers to spinners from base of tubercles; suffused with greenish-yellow; margins acute-crenate, stained more or less with dark olive-green; a similar border occurs on posterior half of abdomen dividing the upper spotted area from the streaked ventral part.

Single specimen, taken in the bush at Ohaupo. *A. T. U.*

Fam. EPISINIDÆ.

Gen. EPISINUS, Walck.

Episinus similitudus, sp. nov.

Mas.—Ceph.-th., long, 1·9; broad, 1·3. Abd., long, 2·6; broad, 1·5. Legs, 1, 4, 2, 3 = 9·2, 8·9, 6, 5·6 mm.

Cephalothorax yellowish-ochreous, lightly mottled with olive-green, more especially along lateral borders; caput speckled with lake; almost glabrous; much depressed, bounded by a rather wide border-hem; broad-ovate; laterally compressed from hind-row of eyes; ocular eminence projects well over *clypeus*, which is inclined slightly forwards; height exceeds one-third of facial space; thoracic indentation dark, forms a deep groove from limit of caput to stalk; striæ well defined; profile-line ascends abruptly and shortly from stalk, dips slightly, rising again to nearly its former plane across cephalic area.

Eyes of fair and nearly equal size, on dark spots, somewhat closely grouped; posterior row sensibly recurved; eyes situated at nearly equal distances, equalling somewhat less than the diameter of a median eye; anterior row strongly recurved, centrals dark, closer to side-eyes than they are to each other, an interval perceptibly shorter than their own breadth; laterals subtouching; latter pairs largest, posterior centrals smallest of eight.

Falces pale-drab, pinkish reflections; slender, conical, vertical, length rather surpasses depth of clypeus.

Maxillæ: Basal half brownish-yellow, fore-end pale-drab; well developed, acutely spathulate, directed towards each other.

Labium brownish; rather wider than long, round-pointed.

Sternum reddish-brown, passing into olive-brown about border.

Legs yellow-ochreous, indications of pre-apical and apical rings on femoral and tibial joints; hairs sparse; few bristle-like spines on patellæ and tibiæ.

Palpi colour of legs; pars humeralis rather stout, somewhat compressed; fore-part of cubital joint turgid; superior contour prominently curved; radial joint tinged with olive-

brown; cup-shape, shallow; pars digitalis well developed, ovate; laminæ bulbi yellow-ochreous, base clouded; ovate; rugose; moderately haired, directed towards each other; genital bulb moderately complicated, the pointed apophyses will most attract attention. A long, wide, tapering, fuscous apophysis springs from near fore-half, follows superior-posterior margin of bulbus, free end curves forwards and upwards, margins involute; second apophysis fuscous, broad, tapers rapidly, projects forwards from extremity of bulb; immediately below the latter organ is a reddish process, basal half depressedly conical, fore-part sharply compressed and pointed.

The *abdomen* resembles that of the female both in form and markings; coloration of type specimen of a somewhat lighter and duller tone.

Fem.—Ceph.-th., long, 1·5; broad, 1·4. Abd., long, 2·5; wide, 1·4. Legs, 4, 1, 2, 3 = 9·2, 9, 6, 4·4 mm.

Cephalothorax ochraceous-yellow, cephalic region suffused with lake; border-hem and striæ mottled with olive-green; sparsely furnished with yellowish hairs. Cephalic parts and eyes do not differ essentially from the male's.

Legs pale-brown, patellary rings dark; yellowish-brown central and distal annuli on femoral, tibial, and metatarsal joints; hairs sparse; bristle-like spines on patellæ and tibiæ.

Palpi pale-brown; moderately long and slender.

Abdomen from the acutely-emarginate base is gradually enlarged to posterior third, from thence pointed to anus; a low tubercular elevation occurs at each lateral angle; two fore-thirds of profile somewhat level, posterior third inclined moderately to spinners; ground-colour yellowish olive-green, clouded with a deeper tone; folium lanceolate, occupies dorsal area from base to tubercles, clouded with fuscous-lake, few whitish spots; border cream-colour, spotted with lake dots; lateral margins and hind-slope clouded with fuscous-green; rather sparingly clothed with yellowish hairs. *Vulva* represents a large, shallow, somewhat reniform area, of an orange-colour, red-lake reflections, rising to a slight central ridge, whose up-turned, superior extremity exhibits two moderate-sized, oval foveæ, divided by a septum perceptibly narrower than their transverse or greater breadth; superior and lateral borders of area bounded by well-developed, incurved costæ.

Pirongia Mountain. *A. T. U.*

Episinus similanus, sp. nov.

Fem.—Ceph.-th., long, 5·8; wide, 1·4. Abd., long, 4·9; wide, 2·3. Legs, 4, 1, 2, 3 = 9·8, 9·1, 6, 4·8 mm.

Cephalothorax dull yellow-ochreous, suffused over cephalic

and medial region with lake-brown; dorsal figure and lateral band olive-brown; former fan-shaped, latter broad; clathrate; hairs yellowish, sparse; ovate; *clypeus* vertical, height nearly equals one-half facial space; thoracic indentation long, wide, deep; striæ moderately defined; thoracic part of contour represents a rather prominent curve, rising above plane of caput; falling abruptly to the petiole; cephalic line nearly horizontal.

Eyes of tolerable and nearly equal size, on dark patches; posterior row perceptibly procurved, distributed at nearly equal distances, median pair furthest apart; anterior row prominently recurved, centrals smallest of eight, separated by rather more than an eye's interval; fully their radius from side-eyes; laterals divided by a space equalling one-fourth their diameter.

Falces yellow-brown, clouded with olive-brown; linear-conical, inclined sensibly forwards, in length barely equalling the pars digitalis of palpus.

Maxillæ acute-spathulate, inclined over *labium*, which is oval, large; organs slaty-olive, passing into a pale tone.

Sternum fuscous-olive; clathrate; broad-cordate.

Legs pale yellow-brown; patellæ and annuli chestnut-brown; latter wide, central and distal; basal rings more or less indicated on femoral and metatarsal joints; armature, fine, sparse hairs; bristle-like spines on patellæ and tibiæ.

Palpi moderately slender; resemble legs in colour and armature.

Abdomen inversely-ovate in outline, depressedly convex; base emarginate, somewhat pointed at spinners; the obtusely-conical tubercles project backwards and outwards from verge of posterior incline. Folium occupies dorsal region, somewhat arrow-shaped, extends to apices of tubercles, margins undulating; olive-green, bordered and stained with fuscous-green; outer margin whitish; sides approximate to chocolate-brown, marked with fuscous-black blotches; suffused with creamy-brown spots, combined more or less into horizontal lines. Ventral surface light olive-brown; shield linear-lanceolate, speckled with light spots; border dusky; very sparingly clothed with hairs of a yellowish colour. *Corpus vulvæ* represents a large, broad, subovate, shallow area, somewhat depressed over the rima genitalis; of a pinkish colour, reflecting a deeper tone; bordered by a brown, bead-like costa, which is somewhat dilated on the lateral margins, tapering off at inferior ends.

Ohaupo, Waikato. *A. T. U.*

Sub-fam. THOMISINÆ.

Gen. XYSTICUS, C. Koch.

Xysticus albo-brunnea, sp. nov.

Fem.—Ceph.-th., long, 1·8; wide, 1·8. Abd., long, 3; wide, 2·5. Legs, 2–1, 4, 3 = 4·9, 4, 3·1 mm.

Cephalothorax creamy-brown, passing into greenish-yellow about ocular region, densely mottled with dark-brown, except round margin and eye-area; exhibits a creamy-olive, broad-lanceolate figure, whose short haft projects towards posterior centre-eyes; integument covered with papillæ; the best-developed project long, strong, claviform, black bristles; ovate, lateral marginal compression slight; squarely truncated; sub-aplanate, sides steep; *clypeus* directed sensibly inwards, height about equal to interspace dividing anterior central eyes; projecting vertically beneath margin of clypeus is a stout, roundly-conical, greenish-yellow process; profile-line ascends from stalk at an angle of nearly 80°, slopes visibly across occiput, dips abruptly from dorsal eyes.

Eyes form two somewhat evenly recurved rows; posterior eyes distributed at nearly equal distances, posited on tolerably prominent tubercular elevations; hind-centrals sensibly larger than fore-median pair, form with them a broad trapezoid, rather wider behind than long; anterior centrals divided by a greater interval than that which separates them from the side-eyes next to them; laterals seated on strongish tubercles; fore-pair plainly exceed hind-pair in size; distinctly larger than centrals.

Falces yellowish pea-green, apices light-brown, tints separated by a dark-fuscous band; conical in outline, deplanate, nearly as broad as long; project at same plane as facial space; armed with strong papillæform, and spine-like bristles.

Maxillæ light-brown, centres occupied by greenish-yellow, elliptic marks bordered with dark-brown; elongated, gradually dilated, fore-third pointed; inclined over *labium*, which is clouded with dark-brown; oval, fully two-thirds length of maxillæ.

Sternum greenish-yellow, apex fuscous-black; series of 6 triangular spots project from between coxæ; elongate mark beneath lip, of the same blackish colour; round-cordate.

Legs light-brown, reflecting more or less a greenish tone; blotched and spotted, more especially on thighs of first pair, with fuscous-chocolate, resolved somewhat into annuli at extremities of joints; two first pairs of about equal strength; second slightly surpasses first in length; third pair as strong and nearly as long as fourth; armature, few erect papillæform hairs, and numerous spine-like bristles; tibiæ and metatarsi of first and second legs, 6 spines; of third leg, 1 on each joint.

Tarsal claws of first and second legs strong, well curved, 7 open teeth increasing in length and strength.

Palpi fulvous, few fuscous spots; armature of legs; palpal claw short, about 6 teeth.

Abdomen inversely-ovate, base truncated; somewhat pointed at spinners; subcomplanate; moderately furnished with long papillæform hairs, and short spine-like bristles; dorsal region suffused with a yellowish-cream colour, with the exception of a central oval patch which has the normal fulvous ground-tint; two dilated T-shaped, fuscous-black figures form a transverse line with the posterior third of the above-mentioned oval mark; two moderately divergent, blackish, irregular streaks occur on basal end and above spinners; ventral surface spotted; shield defined by a U-shaped dotted band. *Vulva* fulvous; viewed from above, represents a somewhat triangular hood, whose lateral extremities are incurved; project over a sub-diamond-shaped, transversely-rugose area.

Single specimen. Bush near Ohaupo. *A. T. U.*

Fam. ATTIDÆ.

Gen. ATTUS, Walck.

Attus ravus, sp. nov.

Mas.—Ceph.-th., long, 2·9; broad, 2. Abd., long, 3·1; wide, 2·1. Legs, 1, 4, 2, 3 = 6, 5·5, 4·9, 4·8 mm.

Cephalothorax chestnut-colour, densely suffused with fuscous-black; glossy; very sparingly furnished with dark hairs, grouped mostly about frontal region; pars cephalica aplanate, limited by a transverse indentation; *clypeus* retreating, depth barely equal to radius of a centre-eye; pars thoracica surpasses cephalic part in length by one-third, moderately dilated; contour of profile ascends from the petiole at an angle of 55°, represents a horizontal line to hind-row of eyes, dips across ocular space.

Anterior row of *eyes* recurved, median pair visibly nearer to each other than they are to side-eyes; laterals one-third size of centrals, removed from them by an interval equal to about their own radius; eyes of posterior row sensibly smaller than anterior laterals, fully one-third further from one another than they are from the latter pair; eyes of second row intermediate; breadth of frontal line exceeds space occupied by hind-row by about the diameter of a lateral eye.

Falces deep lake-brown; transversely rugose; vertical; subconical, of somewhat even breadth; about as long as the radial and digital joints of palpus together.

Maxillæ straight, dilated, round-pointed; *labium* subconical, nearly two-thirds length of maxillæ; organs chestnut-brown.

Sternum greenish-brown, fuscous clouds.

Legs brownish-yellow; coxæ have light olive-green clouds; femora, patellæ, and tibiæ more or less clouded with fuscous-black; metatarsi exhibit basal and distal dusky rings; spine armature normal; hairs dark, fine, tolerably thick.

Palpi brownish-yellow, green tinge; hairs white and black; humeral joint incrassated forwards, subcompressed, about as long as terminal article; cubital and radial joints somewhat cup-shaped; radial shortish, produced on outer side into a moderately long, forward-directed process, with involute margins; pars digitalis bright yellowish-chestnut; exhibits two dark rings, one within the other; genital bulb—viewed from outer side, somewhat slipper-shape, from beneath subovate; apex constricted, prominently so on outer side; free, reaches back to the pars cubitalis; base perceptibly constricted; fore-end occupied by a rather large fovea, encircled by a fuscous costa.

Abdomen ovate, subdepressed; somewhat thinly clothed with white hairs, sparingly so on fore-half; stone-colour, tinged with green; dappled with fuscous-green, somewhat densely so over superior aspect of posterior third; folium ovate; brown, clouded with a darker shade; glossy.

Single example. Wellington. *T. Kirk, F.L.S.*

Attus suffuscus, sp. nov.

Fem.—Ceph.-th., long, 3; wide, 2·2. Abd., long, 4·5; wide, 2·5. Legs, 1, 2–4–3 = 6·4, 5 mm.

Cephalothorax fuscous-mahogany colour; hairs dark, short, thin; cephalic part limited by a tolerably deep and large subcircular depression; profile-contour ascends from stalk at an angle of 40°, dips perceptibly at median indentation, from thence falls with a slight curve to frontal margin.

Anterior row of *eyes* nearly equidistant, side-eyes fully one-third size of centrals; posterior pair perceptibly smaller than fore-laterals, posited on slight eminences; eyes of second row placed centrally between fore- and hind-pairs; ocular area represents a quadrilateral figure one-third wider than long.

Falces lake-brown; transversely rugose; flattish, about one-third longer than broad; profile-line of outer margin strongly curved.

Maxillæ rather prominently dilated, roundly pointed; *labium* conoid, apex rounded; visibly more than half length of maxillæ; organs ochraceous, olive-green tone.

Sternum olive-yellow; elliptical, perceptible eminences opposite coxæ.

Legs brownish-yellow, tinged with olive-green, passing towards extremities into a reddish-chestnut, clouded, espe-

cially first pair, with black-brown. Hairs black, fine; spines normal.

Palpi, axillary and humeral joints yellow-brown; three following articles olive-green.

Abdomen elongate-ovate, subconvex; hairs light, somewhat thinly interspersed; ground-colour lightish olive-brown, passing into a paler tone over central part of dorsum; specific markings obscure, dark-brown; two longitudinal lines, which diverge posteriorly, occupy the pale central area; sides longitudinally striped; ventral surface brownish-yellow, displays three stripes converging towards and terminating near spinners in a circular spot. *Vulva* olive-brown, fore-corners chocolate-brown; semi-oval elevation; the superior margin which connects the stigmata is truncated, somewhat turgid and abrupt, exhibits on its face two oval foveæ, separated by a projecting septum, rather narrower than their transverse diameter.

Single specimen, contained in *Mr. T. Kirk's* Wellington collection.

Attus kirkii, sp. nov.

Mas.—Ceph.-th., long, 3; broad, 2. Abd., long, 3·5; broad, 2. Legs, 1–2, 4, 3 = 8·3, 6·8, 6·2 mm.

Cephalothorax rich brown-pink, sides and caput clouded with black-brown. Hairs yellowish, form a rather thick fringe over verge of frontal margin; circle round eyes orange-red, sparse; cephalic part sensibly dilated forwards; limited by a large, transverse indentation, which exhibits on its posterior slope a longitudinal groove; *clypeus* in height barely equal to radius of a side-eye; fringe pale-yellow, dense; thoracic part slightly rounded; profile-contour ascends from stalk at an angle of 45°, dips at indentation, slopes moderately across caput.

Anterior row of *eyes* recurved; laterals separated from centrals by an interval equalling one-half their own radius, a little more distant from them than they, the centre-pair, are from each other; eyes of posterior row sensibly smaller than the fore-laterals; their space equals that occupied by the latter pair; small eyes equidistant between fore- and hind-laterals; ocular square one-third wider than long.

Falces brownish-lake; rugose; sparingly haired; broad-oval, flattish, projecting.

Maxillæ deep brown-pink; dilated, roundly truncated, inferior angle somewhat pointed.

Labium roundly-conical, one-half length of maxillæ, concolorous.

Sternum brownish-yellow, oval.

Legs brownish-yellow; anterior pair more or less suffused

with deep brown-pink; tibiæ and metatarsi of second legs suffused with red-chestnut; femora of two first pairs have four spines, 1, 1, 2; hind pairs, 1, 1, 3; tibiæ of first, 2, 2, 2 beneath, 1 side spine inner aspect; tibiæ of second, 2, 2, 2, side spines 2; metatarsal joints, 2, 2; thighs of two hind-pairs, 1, 1, 3; tibial joints, 8 somewhat irregular spines; metatarsi, 6, three of which form a ring; hairs somewhat sparse, short, yellow, adpressed; black hairs more or less erect; tarsal claws, first pair, outer, 1 strong tooth; inner, 15 short close teeth; claw-tuft well developed.

Palpi lake-ochreous, stained with olive-green; moderately furnished with dusky hairs; pars humeralis perceptibly compressed, incrassated forwards; in length exceeds the two following joints together; cubital joint moderately dilated, one-third longer than penultimate article; pars radialis produced on outer side into a tolerably long, black process, directed forwards, inward-curved, basal half broad, fore-half rapidly compressed; lamina elongate-ovate; fairly well haired; genital bulb ovate, moderately developed, rugulose; exhibits on outer side of anterior half a large, subtriangular indentation, apex directed forwards, bounded, except across base, by a turgid, reddish costa; viewed from outer side, the costal ridge is plainly prolonged round base of bulbus; inner margin of bulb bordered by a somewhat membranous, reddish costa, which reaches to apex; projecting from the latter part is a short, black process, resembling a stout, broken bristle.

Abdomen elongate-ovate in outline, subdepressed; hairs black and yellow, thinly interspersed. Folium occupies dorsal area, light olive-brown, on its fore-third appears a large reddish spot, which without any determinate limits gradually fades into the ground-colour; a series of 6 more or less acute brown chevrons, decreasing in size, extends from the above-mentioned spot to spinners; lateral margins longitudinally wrinkled; portion of the upper series has a deep olive-green colour, and forms a border to folium. Ventral region yellow-brown; shield defined by an olive-green border.

This rather handsome *Attus*, which was captured near Wellington, I have much pleasure in naming after *Mr. T. Kirk, F.L.S.*

Attus tenebrosus, sp. nov.

Mas.—Ceph.-th., long, 2·8; broad, 1·6. Abd., long, 2·3; broad, 1·4. Legs, 1, 2–4, 3 = 6·5, 5, 3·9 mm.

Cephalothorax dark mahogany-colour, dorsal area mostly occupied by a reddish-mahogany, lanciform figure; sparingly clothed with yellowish and fine black hairs, former tufty over eye-region; cephalic part limited by a large circular depression; depth of *clypeus* about half breadth of a side-eye; fringe

yellowish; thoracic part less than one-third longer than cephalic, sides moderately dilated; profile-line ascends from stalk at an angle of 50°, dips forwards with a slight incline and curve.

Anterior row of *eyes* distributed at nearly equal distances —less than radius of a side-eye; dorsal pair do not differ perceptibly in size from fore-laterals, placed slightly nearer to each other than are the former pair; eyes of second row intermediate; square fully one-third wider than long.

Falces lake-chestnut; transversely rugose; sparingly haired; oval, flat, rather longer than broad, directed forwards.

Maxillæ long, rather sharply dilated and rounded at extremity. *Labium* oval, barely one-half length of maxillæ; organs brownish, approximating to olive-green, passing into a red-chestnut about margins.

Sternum light-brown, dappled with olive; oval.

Legs: First pair orange-ochreous; femora clouded, especially inner side, with dark-brown; tibial, metatarsal, and tarsal joints have bright reddish reflections; three hind-pairs light-ochreous, except the tibiæ, metatarsi, and tarsi of second legs, which have a similar shade to the respective joints of fore-pair; hind-pairs have more or less evanescent, olive-brown annuli; second and fourth legs of about equal length. Hairs fine, sparse; spine armature normal.

Palpi ochraceous, penultimate and digital joints reddish; pars humeralis suffused with olive-brown; latter article arcuated, incrassated forwards, projects 2 spines; cubital plainly longer and stouter than radial joint, which projects forwards from outer side a black, tolerably long and slender, down-curved process; pars digitalis nearly equals the two preceding joints in length; lamina elongate-ovate, moderately haired; genital bulb depressedly conical, moderately developed; bordered on outer side by a wide, reddish callus—contiguous to lamina—that bends abruptly into its emarginated third.

Abdomen ovate, moderately convex; sparsely clothed, chiefly on lateral margins, with short, yellowish hairs; stone-brown, lightly dappled over dorsal region with reddish-brown; median band chocolate-brown, somewhat evanescent, terminates at posterior half; two branch streaks project forwards; second half exhibits five broad, more or less arrow-shaped figures, approximating to olive-brown; lateral margins horizontally streaked with olive-brown; spinners orange-yellow.

Single specimen. Hunua. *T. Broun.*

Attus adustus, sp. nov.

Fem.—Ceph.-th., long, 3·4; wide, 2·2. Abd., long, 4; wide, 2·4. Legs, 1–4, 2, 3 = 6·2, 5·1, 4·9 mm.

Cephalothorax dark mahogany-colour, deepening in tone about lateral borders; sides rather sparingly clothed with whitish and orange-red hairs, latter have a brighter hue on frontal margin; cephalic part aplanate, limited by a somewhat T-shaped groove, contained within a subcircular indentation; *clypeus* in height less than the radius of a side-eye; thoracic part slightly surpasses cephalic in length; profile-line ascends from stalk at an angle of 45°, inclined visibly forwards across caput.

Eyes rather large; anterior row perceptibly recurved, centrals contiguous; laterals about one-half size of median pair, removed from them by one-fourth their own breadth; dorsal eyes sensibly smaller than laterals; eyes of second row equidistant between fore- and hind-laterals.

Falces lake-brown; rugose; conoid, vertical, flattish, somewhat gibbous at base in front, short.

Maxillæ roundly-spathulate, slightly inclined from *labium*, which is roundly-conical, nearly half length of maxillæ; organs reddish-mahogany.

Sternum yellow-brown; oval.

Legs: First-pair light mahogany-colour; hind-pairs yellowish-brown, greenish and reddish reflections; indications of annuli on metatarsi of fourth pair; tarsi of third and fourth ringed. Light hairs sparse; black, fine, erect; spines normal.

Palpi yellow-brown; penultimate and digital joints reddish; well furnished with dusky, fine hairs.

Abdomen elongate-ovate, projects moderately over base of cephalothorax; tolerably well clothed with short, adpressed, pale-yellow and orange-red hairs; yellowish-brown, approximating to olive-brown, flecked with somewhat obscure dots of a lighter tone; indications of fuscous chevron on medial line; lateral margins exhibit a series of dark, longitudinal streaks, the lighter interspaces haired. Ventral surface pale brown-pink, pale flecks; shield similar shade, border and median stripe brown. *Vulva* brownish, two converging, elongated patches occur on the clouded base; moderately elevated; close to the somewhat projecting superior margin are two deep, circular foveæ, separated by a broad septum, surpassing their diameter in breadth.

Two examples of this species were captured amongst the dry foliage of *Cordyline australis* in the bush near Ohaupo; and a larger example, less haired, was taken at the base of Pirongia Mountain. *A. T. U.*

ART. XXII.—*On Eels.*

By E. O'H. CANAVAN.

[*Read before the Wellington Philosophical Society, 13th July, 1892.*]

MORE than forty years ago a friend of mine asked me if I ever studied the habits of eels, or if I knew how they propagated their species. He further told me that it was worth any trouble I might take to study the subject. He afterwards gave me such advice as he thought would assist me. He was a gentleman who had travelled much, and who was very fond of hunting. He made some expeditions to North America, where he spent years hunting; and he wrote a book containing an account of them, which showed that he possessed a sound knowledge of natural history. This gentleman's name was Captain John Palliser, of Cummeru Lodge, County Waterford, who, I regret to say, has not lived to learn the results of the inquiry he then started.

My first step was to inquire among the old residents of the country, as I found that they had traditions which often lead an inquirer on the right path. But in this case I was disappointed. Some said that eels came from horse-hair; others said they came from the eggs of a fly; and others said they travelled over the land from one stream or pool of water to another. They all agreed on one point—viz., that, no matter where a hole deep enough to get filled by percolated water was made near any river or pool, that hole of water very soon became inhabited by eels. They even made use of this fact to prove their various assertions. I found that in various rivers of the country weirs were fixed, and that the eel-fishing was carried on during the late winter and early spring. These fisheries are very valuable, a rental of thousands of pounds being paid annually for the privilege of fishing at one weir. This was my first clue—viz., that at a certain season every year eels went in numbers down the rivers towards the tidal waters. I found that eels travel and feed at night, and that they sometimes travel in the dark waters of a flood. I found that in the latter end of the fishing-season eels contain a lining of fat on each side, lying just as the layers of ova lie in the oviparous fish. On inspecting this fat with a powerful glass I found it to be contained in minute cells, and that it very much resembled ova. I therefore, by the advice of Captain Palliser, had the fat of twelve eels treated in the same manner that the ova of trout and salmon are hatched; but at the end of three months I could render this fat into oil just as I could eel-fat not so experimented on. This con-

vinced me that I should look further to find their mode of propagation. About the year 1851, while salmon-fishing in the River Suir, near Clonmel, about the end of July and the beginning of August, I discovered eel-fry coming up the river in numbers, as whitebait come up other rivers. They were perfect in structure, but very small—small enough to run through any interstice that would admit a drop of water through it. This accounted for eels getting into the water-holes near rivers before alluded to. I followed these fry, and found them forming a deep narrow column along the right bank of the river, close to the edge, and extending for miles. Up every streamlet, no matter how small, a detachment from the main body made its way over every obstacle. It was very interesting to watch the little creatures struggle up the wet grass, stones, and weeds, as, no matter how often they were washed off, they renewed their efforts until they succeeded. For the succeeding four years I observed the eel-fry ascending this river at about the same time each year. In the north and west of Ireland, and in Scotland, I also observed eel-fry ascending rivers. In the rivers of the west of Ireland they are very numerous. The people there call them "luogues" (singular; pronounced "lū-ōg"), and they catch and use them for food, as we use whitebait, and a very good dish they make.

When in Collingwood, New Zealand, I observed eels coming down the river to the tidal waters. There was a fall in the river which terminated the tides (except spring-tides), and on this fall, in October and November, the boys, with gaff-hooks, used to catch eels coming down the fall; and in February and March they would catch eels going up. This proved that eels go up rivers after visiting the tidal waters; but I noted this also on the River Suir and a tributary of it called the Anner. In Porirua, New Zealand, I noticed that eel-fry went up the river in February and March. In 1890 mining speculations took me to Cullensville, and, as is my custom, I tried all the streams for the fresh-water pearl-mussel (*Unio aucklandicus*), which I found so abundant in the streams and lakes of West Wanganui and in the streams of Wanganui North. I did not discover any mussels, but on two occasions I found two eels entwined so that I was able to throw one pair out on the bank. They were too quick for me, and got back safely to the water before I could catch and examine them. Of course they became separated when I threw them out. In January, 1891, I, with others, was fishing in the stream near the Grove, in Queen Charlotte Sound, at night, and, having caught some eels, returned to camp, about nine miles inland. On cleaning the eels the following morning I found in one a bag or matrix, distinct from the alimentary

canal; and in this matrix eleven small eels that had life enough to move about, although the mother was dead some hours. They had not yet arrived at maturity. The dorsal fin was visible, and so were the head and other parts, all of which appeared to be beneath a thin film. The head, one would say, was not perfect, although the shape was distinguishable. In January, 1892, I caught two of these female eels. The time was later in the month than when I caught the one the year previous, and the young ones were more perfect. These females were dead long before the other eels showed any distress from want of their native element.

What I have discovered I arrange as follows: *First*, that eels are night fish—*i.e.*, that they travel and feed at night. *Second*, that they go to the tidal waters (when practicable) to deposit their young. *Third*, that they bring forth their young alive in the tidal waters. *Fourth*, that they go up the rivers again, and so do their young ones.

Since I wrote the foregoing I have had a conversation with Mr. Henry Redwood, of Spring Creek, a good and keen observer of nature. He said that he had frequently observed the matrix that I have described, and found in it the young eels as I found them.

ART. XXIII.—*On a New Zealand Variety of* Floscularia coronetta, *Cubitt.*

By Archdeacon STOCK, B.A.

Communicated by W. M. Maskell.

Plate X.

[*Read before the Wellington Philosophical Society, 3rd August, 1892.*]

THE animalcule known as *Floscularia coronetta* is rare in England. It is worth recording that a *Floscularia* almost identical with the English form was found by me in water at the back of the Hutt Parsonage. The drawing (Plate X.) accurately represents the New Zealand form. The only differences between this and the English rotiferon is that the arms in my specimens are longer than those in Hudson's and Gosse's drawings, and the knob at the end of the arms is not circular, as in their drawings, but oval. The animal is rare here, as well as in England.

Art. XXIV.—*Remarks on the* Carabidæ *of New Zealand.*

By Captain T. Broun.

Communicated by Professor Hutton.

[*Read before the Philosophical Institute of Canterbury, 7th September, 1892.*]

I have not till now had the honour of addressing the members of the Philosophical Institute of Canterbury, but, as about one-half of the predaceous ground-beetles collected during the past year, and submitted to me for examination, belong to your district, I thought that a brief paper on the subject might be acceptable.

I may here state, for the information of those who have not the inclination or leisure to study entomology, that the group *Carabidæ* is one of the most highly developed of the order Coleoptera, and consists almost entirely of useful insects. I apply the term "useful" because the species subsist almost wholly on other insects, which they attack either on or in the ground, and on trees, and thus check the too rapid increase of many kinds of beetles, locusts, &c., which, if it were not for the presence of *Carabidæ*, would soon become better known even to those who care nothing for entomology as a study, but who do concern themselves with their fields of grass, crops, and trees.

It is becoming evident that all engaged in agricultural pursuits ought to make themselves acquainted with certain forms of insects, so that they could discriminate between useful and noxious kinds. I think that all such people should possess in their own houses, or in easily-accessible public buildings, at the least, a simple collection of typical species of both sorts. A small box about a foot square, filled with selected specimens, would in many cases afford more practical information than whole yards of printed matter.

Perhaps I may be permitted to record an incident that happened in my presence. I was staying at a farmer's house one night during a collecting-tour, and whilst talking to the hospitable farmer his wife came into the room in great glee, and informed her husband that she had at last killed "that horrid fly." I asked her to let me see the insect, which on examination proved to be one of the most valuable we possess—one of the *Ichneumonidæ*, which by means of its ovipositor inserts an egg into the body of a caterpillar or other soft-bodied creature. The egg soon hatches, and the larva feeds on the intestines of its host until nothing remains but the skin. This provides a comfortable dwelling-place for the ichneumon

during its metamorphoses, and in due time the imago emerges, prepared to do to some other insect what its mother had already done. I explained these matters to the worthy couple, and I feel sure that the farmer or his wife never molested one of these "horrid flies" again.

Another, but somewhat different, case was brought to my notice a short time ago. A gentleman in Canterbury sent me a specimen of an insect, asking me to name it for him. In his letter he informed me that an orchardist had given it to him, telling him that the beetle had been eating the scale-insects which infested his apple-trees. I at once informed the gentleman referred to that if the orchardist would carefully examine his fruit-trees later on he would find that the beetle was boring *into* some of his trees instead of ridding them of scale-insects. The beetle is a *Gonipterus*, a destructive weevil imported from Australia, most likely amongst the seeds or young plants of *Eucalypti*.

I have mentioned these facts in order that you may have some idea as to the kind of knowledge possessed, I fear, by very many individuals who hope to gain their livelihood by the cultivation of the soil, but who, it must be apparent, are likely to suffer heavy pecuniary losses through misdirected observation, neglect, and—may I add?—ignorance.

After this digression I shall endeavour to confine my remarks to the *Carabidæ*.

The new species discovered during the last collecting-season bear the following names:—

Trichosternus crassalis	No. 2434,	Man. N.Z. Coleop.
Pterostichus arduus	No. 2435,	"
" scitipennis	No. 2436,	"
" delator	No. 2437,	"
Sympiestus oculator	No. 2439,	"
Tachys oreobius ..	No. 2441,	"
" cavelli ..	No. 2442,	"
Oöpterus puncticeps	No. 2440,	"

The first-named species, *Trichosternus crassalis*, is the finest in New Zealand so far as we know at present. *Trichosternus antarcticus* was formerly considered the largest and typical species, but the new one is about one-third larger. It was found at Albury by Mr. W. W. Smith, of Ashburton. This gentleman has been kind enough to place at my disposal a good series of several species of *Carabidæ*, collected near Ashburton within the last two years. Amongst these are what I consider two or three varieties of *Trichosternus antarcticus*, which I believe to be common in the neighbourhood of Christchurch. If one of these varieties, the least like the typical form, be examined by itself by some one who has not most of the described species, it would, I have no doubt, be named as

a distinct species: this would certainly have been the result had it been sent to Europe. The other varieties in my cabinet, however, show that the extreme form is connected with the typical one. When more material can be accumulated I hope to be able to define these, and perhaps other varieties, in such a way that future workers will not mistake them for distinct species. The genus *Trichosternus* occurs in Australia as well as in New Zealand: it may be distinguished from the closely-allied *Pterostichus* by the presence of coarse hairs on the hind part of the prosternum; but, as these hairs are liable to be removed by accident, the chief, in fact the only, differentiating character assigned to this genus by Baron Chaudoir is not a very good one. I feel tolerably certain that I have in my collection several species of *Pterostichus* that are really *Trichosterni*, and they must stay as they are until quite perfect specimens can be obtained. As these insects live on the ground, it often happens that some damp soil adheres to them; this, on being cleaned off, carries away with it the distinguishing generic character.

The next on the list, *Pterostichus arduus*, was brought from Mount Arthur amongst other Coleoptera by Messrs. Cheeseman and Urquhart several years ago, but, as I had only one example, and that a female, I set it aside in the hope of getting a specimen of the other sex. As I have been unable to get one I have now described it.

Pterostichus scitipennis was found on Mount Pirongia, in the Waikato district, by Mr. A. T. Urquhart, the well-known writer on spiders. It is about half an inch long and nearly one-sixth in breadth, of a pure-black, rather glossy, and has beautifully-sculptured elytra, a circumstance that suggested its specific name. The specimen, a male, is unique as yet.

The third *Pterostichus*, *P. delator*, is another of Mr. W. W. Smith's novelties from Ashburton. It most nearly resembles *P. sinuellus*, which was discovered by Mr. H. Suter, a resident in your city and an able conchologist, at Dyer's Pass.

The genus *Pterostichus* is nearly cosmopolitan. The New Zealand species, now pretty numerous, have been divided into five sections as a key to identification, the number of setæ, or hairs, on each side of the thorax being adopted as the basis of classification. This key, or table, lies at Wellington awaiting publication, along with the descriptions of about six hundred new species of our Coleoptera. When published, the key will be very useful to any one who wishes to study our *Carabidæ*, but it has one defect—the lateral setæ may be rubbed off, and in such a case it would be difficult to determine the particular group or section in which the species under examination should be placed. Unfortunately it cannot be helped, as these hairs are the only means of grouping the species.

The next name on the list is *Sympiestus oculator*. One of this species was found on the Hunua Range, near Drury, by Mr. Koebele, the American entomologist. This is an endemic genus, and at present comprises three species, two of which were found in Canterbury and Westland. They are moderately small, oblong insects, with rather prominent eyes, and long, acuminate, terminal joints to their palpi. They seem to be rare.

Tachys (?) *oreobius* is one of those small *Carabidæ* that are so difficult to manipulate and locate in a satisfactory manner. Allied forms are numerous in most parts of the world. This species was brought from Mount Pirongia amongst leaf-mould by Mr. A. T. Urquhart, and I picked it out. It is less than the twelfth part of an inch in length, so you can imagine the difficulty of making a thorough examination of the organs attached to the mouth, and of ascertaining exactly the structure of the tarsi. When several specimens are available dissection can be resorted to, but when it is an important matter to mount and preserve the only specimen extant, or in cases where only one of each sex has been found, it is not advisable to break up either of them.

Tachys cavelli is a somewhat similar though larger species. One individual was found at Capleston, in Westland, by Mr. A. T. Cavell, in whose honour I have named it. The country near Capleston, formerly known as Boatman's, is one of the best collecting-grounds known to me, so far as I can judge by the material placed at my disposal.

The last species I have to refer to in this paper is *Oöpterus puncticeps*. I owe my specimen to the kindness of Mr. H. Suter, who found it at Port Hills. The genus is a "purely antarctic form," according to the late H. W. Bates, who was perhaps the greatest authority in Europe on the Geodephaga. The species are closely allied, and not at all easy to define accurately by description. They occur in the Auckland, Soledad, and Falkland Islands, which, as you are aware, are separated by wide oceanic expanses. This distribution is remarkable, as all the species are terrestrial in their habits, and, moreover, are without wings. I have at different times described several species, but the present one may be identified by the well-marked interocular punctures.

It is a comparatively easy matter to collect the members of this group. On turning over a log, especially one that has been lying on the ground for some time, some shining greenish-black, or pure-black, oblong insects will be seen. These are *Carabidæ*. They are mostly nocturnal in habit, and conceal themselves during daylight under decaying logs, under stones, and beneath loose bark. Those found under bark, as may be readily supposed, are usually small and rather flat; they are

also more prettily marked or variegated. As they soon show their activity when disturbed, the collector should be ready to secure them at once, otherwise they elude capture by hiding amongst the adjacent herbage, or by burrowing into the ground, where they form their nests. They should be put into a wide-mouthed bottle, about half-filled with the bruised leaves and twigs of the common laurel. This killing-material costs nothing, and can be prepared in a few minutes. Two or three leaves may be held on any flat iron—an old axe or tomahawk answers the purpose—with one hand, whilst a hammer held in the other soon reduces the leaves to a sort of pulp, which should be pressed into the bottle. When out collecting, two bottles should be carried, the "killing-bottle" and a reserve one. Every now and then the beetles should be turned out of the first—as soon as there are three or four dead specimens—as the living very often mutilate the dead, and spoil them as cabinet specimens, but by transferring them to the "reserve bottle" the risk of injury is greatly reduced. When sent to be named they should be packed amongst bruised laurel in common tin match-boxes, which generally form a sufficient protection during transit by post. The worst killing-material is, in my opinion, alcohol: it makes the insects brittle, so that any attempt to open the mandibles or "set out" the limbs results in damage. As the *Carabidæ* do not travel far, almost every separate locality produces some species peculiar to itself, and for scientific purposes it is important that they should be described before the progress of settlement dooms them to extermination. I hope some of the members of your Institute will take enough interest in the matter to respond to my appeal. I have seen very few beetles from Canterbury, and I shall be glad to name those that may be sent to me. The mountainous region will yield, I feel sure, a considerable number of interesting forms.*

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* For the systematic description of the foregoing species the reader is referred to page 1400, Part VII., of the "Manual of the New Zealand Coleoptera," by Captain Thomas Broun; published by the New Zealand Institute, Wellington, 1893. This is a continuation of the same author's Manual, published by the Museum Department, Part I., June, 1880; Part II., May, 1881; Parts III. and IV., April, 1886: 973 pages in all, and describing 1,756 species. Additional species, bringing up the number to 2,591, are described in Parts V.–VII., which will be issued concurrently with this volume of the Transactions.—J. H., Ed.

ART. XXV.—*On some Mites parasitic on Beetles and Woodlice.*

By W. M. MASKELL.

[*Read before the Wellington Philosophical Society, 26th October, 1892.*]

PARASITES, as Thackeray says, exist always; and there is perhaps no portion of the great animal kingdom (excepting man) which exhibits the truth of this saying more fully than the various tribes and families of insects, and of the Crustacea. These organisms, which are themselves commonly engaged in preying upon their fellow-creatures, are subject to an infinite variety of hostile attacks from beings smaller than they are, and their lives (perhaps fortunately for the rest of creation) must be by no means happy ones. It would be a very useful thing if the study of the different insect parasites in New Zealand were seriously undertaken, and it is to be hoped that some day, when a proper Agricultural Department exists here, this will be done. Meanwhile every contribution to knowledge is valuable, and the following note is offered as a small instalment.

Parasites upon the smaller forms of animal life, such as insects or Crustacea, may be of many kinds. Some are themselves insects, such as the minute Hymenoptera which prey upon the so-called "blights"; others are Entozoa, internal parasites preying upon the very intestines of their hosts; others, again, belong to the great order Arachnoidea, which includes not only the spiders but also the different mites. Mites feed on both animal and vegetable matter. Some are harmless, some injurious, some useful, some even murderously noxious. In the sheep-scab and human itch we have examples of abominable nuisances; in the almost invisible little animal which swarms often in cabinets and boxes we have an annoying and destructive enemy; in the tree- or beetle-mites we have frequently very useful scavengers; in sugar or in biscuit, mites are both injurious and offensive; while we consider that the presence of mites is not only harmless but even necessary to the proper ripeness and flavour of certain kinds of cheese which are inferior without them. Amongst all these varieties of mites there is one family which has for its special object the preying upon some species of animals which are themselves enemies to man; and two of these I am introducing to you this evening. If anybody here present has occupied himself with farming he will be only too well acquainted with what are known as "wireworms"; while anybody who grows flowers in pots has had troubles with the little animals called "woodlice." The mites which I now exhibit, none of which

are larger than a very small pin's head, devour and annoy these two animals, and are therefore friends of man.

The great order Acarina, or mites generally, includes many subdivisions, of which one is that of the *Gamasinæ*, or mite-parasites; and this, again, contains several genera, of which one has received the name of *Uropoda*. It is the habit of *Uropoda* to attach itself (not singly, but in clusters of as many as can climb on) to the back of some insect or animal, preferably a more or less subterranean one, and there to live, move, and have its being. A glance at the specimen which I exhibit will show an unfortunate little beetle so completely covered with numbers of mites that it is not easy to make out its body. The specimen and its parasites are now dead, but when they were alive it seemed not easy to understand how so many mites could hang on to so small an object; and it is only by close observation and by trying to pull some of the mites off that one discovers a very fine silky hair fastened by one end to the beetle and by the other to the mite, which effectually prevents the latter from falling off, and, indeed, fastens it on rather firmly. Naturalists, I believe, are not yet fully acquainted with the nature of this hair, or cord, though Mr. Andrew Murray says that the mite can detach itself if it pleases. Whether this is so or not it seems clear that the victim has no such power; and the condition of an insect or of a woodlouse under these circumstances cannot be at all enviable.

Uropoda may sometimes, in wet weather, be found adhering to stones instead of to animals; but it would seem that the congenial home of these mites is the skin of some other small animal.

On the stages of the two microscopes on the table are shown specimens of mites taken in the one case from a woodlouse (*Oniscus* sp.), in the other from a small *click-beetle* (*Elater*), the full-grown form of the "wireworm." It will be at once seen that both are yellowish-brown, oval, flattish, and hard; and that they have the eight feet and the mouth-organs characteristic of the true mites. Possibly very close observation might discover minute differences in the arrangement of the bristly hairs visible on the surface of the body, and these differences might suggest the separation of the specimens into two species. I do not, however, see any necessity for this, nor shall I attempt to distinguish these animals from the European mites which are known to have precisely similar habits. The present note has therefore been put forward only to record the existence in New Zealand of these minute parasites, which, although apparently not very common, are doing something to help man in his warfare against the enemies to cultivation.

Assuming, then, that these mites are identical with, or very slight variations from, the European form, they must be recorded as follows :—

Order ARACHNOIDEA.

Fam. GAMASINÆ.

Sub-fam. GAMASIDÆ.

Gen. UROPODA, Latreille.

Species *Uropoda vegetans*, De Geer.

Minute mites, parasitic upon Coleoptera (*Elater*) and Crustacea (*Oniscus*) in New Zealand. Form flattish, subcircular; colour yellowish-brown; attached in clusters by fine threads to the host. Characters generally of *Gamasinæ*: Eyes none, mandibles chelate, feet eight, each with a double claw and a minute caruncle or pad.

Localities, up to the present: Christchurch (on *Oniscus*); Wellington (on *Elater*). The Wellington specimens were sent to the Museum lately by Colonel Humfrey, of the Hutt.

ART. XXVI. — *Further Coccid Notes: with Descriptions of New Species from Australia, India, Sandwich Islands, Demerara, and South Pacific.*

By W. M. MASKELL, Corr. Memb. Roy. Society of South Australia, Registrar of the University of New Zealand.

[*Read before the Wellington Philosophical Society, 18th January, 1893.*]

Plates XI.–XVIII.

THE widely-separated localities from which come the insects referred to in the following pages are evidence of the increased interest taken nowadays in Coccids all over the world. I was once told by an entomological friend, as an excuse for his not attempting to collect or study this family, that there were so few species in it and so little was known about them. Apart from the fact that, to most people, rarity and want of information would be rather incentives to study than reasons for neglect, the first statement is scarcely accurate, and the second becomes less so every year. I do not myself think that the multiplication of species tends to render a family either more interesting or more important; and probably some judicious pruning amongst the many thousands of species of Coleoptera or Lepidoptera would bring about a most useful reduction of their numbers, as some naturalists seem to

have a craze for the making of species on the slightest provocation. Still, any one who would imagine the Homoptera to be a small or unimportant order would be much mistaken. Coccids are but one family of that order, and have only been really studied for some thirty years; but of that alone nearly seven hundred species are now known (1892), and scores of others are sure to be discovered every year. The Aphids, Psyllids, and Aleurodids have as yet been scarcely touched; the Cicadids and other families are constantly receiving additions. It would probably not be an exaggeration to estimate that there are from twenty to thirty thousand species of Homoptera existing in various countries, not more than a seventh of which, perhaps, have been made known to science up to the present day.

There would seem to be a quite sufficient field here for the entomological student. As regards New Zealand, I have myself described eighty species of Coccids, four of Psyllids, and five of Aleurodids, all of which may be considered as indigenous, besides several exotic introduced species. Certainly the two last families, and probably the first, are still more largely represented in this country, and nobody has yet made any investigation of the Aphids. I hope therefore that ere long the New Zealand Homoptera will receive the attention to which their importance clearly entitles them.

It is satisfactory to note that since 1870 the number of homopterologists has been steadily increasing. At that time, with the exception of Signoret, Lichtenstein, Bouché, and Fitch, scarcely anybody studied the order. Now the workers are numerous, either as collectors or describers, and they are spread all over the world. In Europe excellent work has been done by Douglas, Morgan, Löw, Newstead, Buckton, Targioni; in America, by Riley, Howard, Koebele, Comstock, Coquillett, &c.; in India, by Atkinson, Cotes, Nietner, Green; in Australia, by French, Olliff, Tepper; and in New Zealand I have received great help from Messrs. Raithby, Smith, and others. Some of these have turned their attention chiefly to that very important branch, the economic relations of the Homoptera to agriculture; others confine themselves to the purely scientific side of entomology. But the result is that the order is being better studied every year, and I look forward to the time when it will receive its due share of attention in New Zealand also.

The following pages contain notes upon several insects already described, and also descriptions of more than thirty new species. The majority I owe to an occurrence which deserves particular mention. It will be remembered that after my publication in 1878 of an account of *Icerya purchasi* that pest became so obnoxious in various countries that uni-

versal attention was drawn to it. My late friend Mr. Crawford, of Adelaide, was the first to discover the "natural enemy," in the shape of a rather large parasitic fly, which he called *Lestophonus iceryæ*. The pest having become exceedingly injurious in California, the United States Agricultural Department at Washington, which is presided over by scientific experts, determined to leave no stone unturned to put a stop to the damage, which was being done to the extent of millions of dollars, and threatened to increase. An officer of the department, Mr. Albert Koebele, was sent to Australia in 1888 to procure supplies of the *Lestophonus* from Mr. Crawford, for the purpose of introducing them into California. Calling on his way at New Zealand, where, in the North, *Icerya* was dreadfully prevalent, Mr. Koebele was fortunate enough to find a much better enemy to *Icerya*, in the form of *Vedalia cardinalis*, one of the *Coccinellidæ* (ladybirds), and, recognising at once the full importance of this insect, he carried away with him to California a large number of *Vedalia*, with the result that in two or three years' time that State was practically cleared of *Icerya*, and its fruit industry saved. Since then *Vedalia* has been sent about the world wherever *Icerya* prevails, with a similar good result in every case.

The foregoing is perhaps only a "twice-told tale," known to many people, although even so it cannot be too often repeated. The public of New Zealand are not so well acquainted with the sequel. The Washington Department, finding that Mr. Koebele's first trip had been so successful, despatched him on a second journey to Australia and New Zealand, "on a search for beneficial insects." The State of California appropriated 5,000 dollars towards his expenses; the department supplemented the sum as required. The object this time was not to fight against *Icerya*, but to obtain the natural enemies of other insect pests very injurious to fruit and other trees, such as *Aspidiotus aurantii* on orange and lemon, or *Lecanium oleæ* on various plants. Mr. Koebele reached New Zealand in October, 1891, spent a day or two with Mr. Wight and Mr. Cheeseman in Auckland, stayed also a day or two with me in Wellington, passed on to Australia, where he remained till July, 1892, and then returned to California. During this time he was successful in discovering a large number of parasitic insects and in despatching supplies of them to America. I have not yet heard what is the final result of his journey. We can only hope that it will be as useful as in 1888.

As far as regards myself, I am indebted to Mr. Koebele for, as stated just now, a large number of the insects referred to in this paper, whether new species or known insects from

new localities; and I am greatly obliged to him for permission to describe them here. But the people of New Zealand owe to him and to the Agricultural Department of Washington a greater debt. For, on this his second journey, recognising perhaps that he received *Vedalia* practically from New Zealand, he attempted to repay us as far as possible by introducing into this country some of the insects known to be very useful in America. His first port of call being Auckland, he at once came into communication with Mr. R. Allan Wight, so well known in the colony as an excellent economic entomologist, and immediately placed in his charge, or, rather, liberated in conjunction with him, several parasitic insects. Of course, these being let loose, it is not possible yet awhile to say positively whether they have made much impression against our various pests; yet I understand from both Mr. Koebele and Mr. Wight that they very quickly set to work, and seemed quite ready to acclimatise themselves, and that in all probability their introduction will be, as far as it goes, successful. The importance of this fact will be readily recognised when it is stated that they included some ladybirds, which are special enemies to what we call the "American apple-blight" (*Schizoneura*), some *Syrphidæ*, and some *Neuroptera* (lacewings), enemies to all sorts of aphides and blights, and some larvæ of *Raphidia*, which feed greedily on codlin-moth. Surely, as I said just now, the people of New Zealand owe a debt to the American scientists who have thus tried to help them.

The introduction of these insect friends is, as I said, satisfactory as far as it goes. I mean by this that, of course, Mr. Koebele on this occasion could not bring a sufficiently large supply; and perhaps it may be a very long time (even with the experience of *Vedalia* before us) ere any beneficial results are visible. But, besides the kindly feeling which prompted Professor Riley and his colleagues in America to send us these things, they have taught us a lesson which I fear will be thrown away. The appropriation, mentioned above, of the Californian State Legislature is surely an example which the Parliament of New Zealand might profitably follow. And the visit of Mr. Koebele, and his well-meant gift, point out to us the necessity (if, indeed, some of us had not seen it before) of some real and practical work being done in New Zealand to help the farmer and the fruit-grower. From every part of the colony come frequently-repeated complaints. Hessian-flies, bot-flies, codlin-moths, wireworms, grass-grubs, snails, aphis blights, scale-insects, all sorts of pests riot and flourish in every district and in every orchard; and they do so because those who have most at stake make no thorough efforts to prevent them. What is required is an Agricultural Depart-

ment, organized like that of the United States of America. We might then hope for some good result. I might multiply instances; but, to confine the question to one point now, Mr. Koebele should never have been allowed to leave New Zealand without making arrangements for further supplies of insect friends to man. He showed by his first consignment that the thing is possible. Had there been here an expert scientist managing a proper department, he would have seen the full value of the experiment, and would have taken care to have it repeated. Our debt to our American friends is, as I said, large; the lesson they have tried to teach us is a good one: all that we want is some man of common-sense and right feeling to acquit the first and learn the second.

This is a matter on which, as this Society knows, I have for a long time endeavoured to induce the rulers of the colony to be reasonable, and to establish a properly-equipped Agricultural Department (or "Bureau," if the term is preferred), under the charge of a properly-qualified scientific expert. Constant dropping of water, they say, will in time wear away a stone. Let me still hope for final success at some future time.

I have also to record my thanks to Messrs. French, Olliff, and Tepper for their Australian insects; to Mr. Cotes for those from India; and to Messrs. Douglas, Cockerell, and others for help, and specimens from different countries. Lastly, I must acknowledge the very friendly terms in which many correspondents have referred to the work on Homoptera contained in my papers of the last fifteen years.

Group DIASPIDINÆ.

Genus ASPIDIOTUS, Bouché.

Aspidiotus cladii, Maskell. N.Z. Trans., vol. xxiii., 1890, p. 3.

This species has been sent to me by Mr. Koebele from Semaphore, South Australia, on *Lepidosperma*. The specimens are much finer, larger, and darker-coloured than those originally described by me from Victoria, but I cannot otherwise separate them.

Aspidiotus acaciæ, Morgan. Ent. Mo. Mag., Aug., 1889, p. 353.

Mr. Koebele has sent me specimens which are so near to this species that I will not separate them: they occur on *Eucalyptus* sp. at Whitton, New South Wales.

Aspidiotus acaciæ, Morgan, var. **propinqua.**

On *Acacia* sp. at Mount Victoria, New South Wales, occurs an insect very near to *A. acaciæ*, differing only in the deeper

red colour of the pellicles, and in the fact that the puparium is almost always very brittle, falling off in the centre, and leaving only a ring with the pellicles exposed. Mr. Olliff has sent me the same insect on *Hakea saligna*, Sydney.

Mr. Morgan did not describe the male of his species. I have the male of var. *propinqua*, which is dark-red, pupating under a white elliptical non-carinated puparium. Length of the insect, exclusive of the spike, about $\frac{1}{50}$in. The feet are rather thick; the ten-jointed antenna is normal.

Aspidiotus aurantii, Maskell. N.Z. Trans., 1878, p. 199. *Asp. coccineus* (Gennad.), Maskell; Scale-Ins. of N.Z., p. 42.

This species is not confined to the orange. I have received it from Australia on *Eucalyptus*, on pear and plum, and on *Laurus nobilis* and *Buxus sempervirens*. Mr. Cockerell has sent me specimens from Jamaica on *Lignum vitæ*, and informs me that in that island it does not seem to attack *citrus*. trees. Mr. D. W. Coquillett states that in California it is found on many plants, the most important of which seem to be rose, pear, grape, and *Eucalyptus*.

In my experience the puparia of *A. aurantii* differ slightly according to the food-plant. On orange and lemon there is a rich, fat, juicy appearance about the puparium, which is reddish-brown. On *Eucalyptus*, *Laurus*, *Buxus*, and *Lignum vitæ* the puparia are lighter-coloured and more solid. Mr. Coquillett, who, like all the American observers, refers to the species as the "red scale," mentions (U.S. Dept. of Agric. Entom. Bulletin No. 23, p. 36, 1891) an insect to which he gives the name "yellow scale (*Aspidiotus citrinus*)" occurring on orange-trees in California. I do not know where the description of this species is to be found, or in what the species differs from *A. aurantii*.

Aspidiotus eucalypti, Maskell. Trans. Roy. Soc. South Australia, 1887–88, p. 102. Plate XI., figs. 1, 2.

I have received specimens of this species from New South Wales (Mr. Koebele) on *Casuarina* sp. Although the puparia were covered with much black fungus, the characteristic deep groove of the female insect was clearly present. I regret that in the illustration of this insect in the South Australian Transactions (pl. xii., fig. 1*d*) this feature is not properly shown, and I have thought it well to give a fresh figure with this paper. A similar groove, though deeper, occurs in *A. articulatus*, Morgan, 1889; but that species differs sufficiently in other respects.

The epidermis of *A. eucalypti* is very distinctly marked with great numbers of minute lines which resemble closely

the marks made on paper by the wetted human finger-tip. In many *Aspidioti* the abdominal segment presents a sort of velvety appearance, from very faint and numerous fine striæ which may be detected upon it; but I do not know any species which exhibits all over the body such conspicuous striations as in *A. eucalypti,* with the exception perhaps of *A. theæ,* as noticed presently.

Aspidiotus rossi (Crawford), Maskell. N.Z. Trans., vol. xxiv., 1891, p. 11.

Mr. Tepper informs me that the specific name of this insect was given by Mr. Crawford in honour of Sir A. Ross, Speaker of the House of Assembly, Adelaide, who first collected it. I have received specimens from Mr. Olliff on *Xanthorrhæa.*

Aspidiotus subrubescens, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 9.

The adult male of this species does not present any remarkable features, except that a fair proportion of the specimens which I have examined this year have been apterous. I have preserved a specimen of the male pupa which shows in a very interesting manner the transformation of the insect. The general form is elongated-oval, with a projection at the posterior extremity simulating the abdominal segment and pygidium of the female; at the cephalic end a commencement may be detected of the separation of the head from the thorax, and at the sides the rudiments of wings can also be made out; the eyes are distinctly being formed: but there is not yet any trace of antennæ or feet; and in the middle the larval rostrum still remains attached.

These male specimens were sent by Mr. Koebele, on *Banksia* sp., Sydney.

Aspidiotus theæ, Maskell. Indian Museum Notes, vol. ii., 1891, p. 59. Plate XI., fig. 3.

I give a figure illustrative of the "lattice-work" pattern visible on the dorsal abdominal surface of this insect; the smaller spaces making up the whole patch may differ slightly in arrangement in various specimens.

This insect exhibits conspicuous fine transverse striations of the epidermis, as in *A. eucalypti.* Also, in many specimens, though not in all which I have seen, there is a deepish groove nearer to the cephalic than to the abdominal extremity: as this is not absolutely constant I did not include it in the specific characters.

Genus Diaspis, Costa.

Diaspis pinnulifera, Maskell. N.Z. Trans., vol. xxiii., 1890, p. 4.

Mr. J. W. Douglas has sent me some insects, clearly belonging to this species, on *Croton* sp., from Demerara. They agree closely with my specimens from Fiji in the very small number of orifices in the groups of spinnerets, and in the two feathery processes on the abdominal margin immediately beyond the lobes.

Diaspis (?) fimbriata, sp. nov. Plate XI., figs. 4–6.

Female puparium circular, flat, very thin and papery, whitish or grey or brownish; pellicles subcentral, yellow or greenish. Diameter of puparium averaging about $\frac{1}{18}$in.

Male puparium unknown.

Adult female yellow, elongated; the cephalic region rather large, separated from the rest by a distinct groove; the abdominal segments tapering posteriorly, and conspicuously segmented. Length of female, about $\frac{1}{17}$in. Abdomen ending in six small lobes, not adjacent, the two median ones being rather larger than the rest. Margin of abdomen without any median depression, minutely crenulated, and bearing conspicuous broad, scaly hairs with serrated extremities, forming a fringe; two of these are between the median lobes, two on each side between the median and the next lobes, three between the second and third lobes, and about ten beyond. Between the fringe and the last distinct abdominal segment there are a few spines. The pygidium exhibits four groups of spinnerets; in each group there are from ten to fourteen orifices; a large number of single spinnerets.

Adult male unknown.

Hab. In Australia, on *Eugenia smithii.* My specimens were sent by Mr. Koebele from Sydney.

I believe that this insect is here correctly assigned to the genus *Diaspis*, although, in the absence of the male puparium, I do not positively assert it. I know of no *Aspidiotus* which has such an elongated form; and, indeed, the insect in its general shape resembles very much *Diaspis rosæ*, Sandberg, though it differs entirely from that species not only in colour, but principally in the absence of a medial terminal depression, in the six abdominal lobes, and in the scaly fringe. As for *Parlatoria*, the case is different, and the fringe might possibly make it approach that genus. But here, again, the form is much more elongated than that of any *Parlatoria* known to me. *P. proteus*, Curtis, varies somewhat, but never seems to get beyond an oval form, and all the specimens which I have seen of it agree with Signoret's statement that it is "widest pos-

teriorly"; whereas *D. fimbriata*, like *D. rosæ*, tapers posteriorly. Further, in *Parlatoria* the fringe extends not only over all the pygidial region, but also to the anterior abdominal segments, while in *D. fimbriata* it is very short. I observe, also, that in Löw's description of *D. visci*, Schrank (according to Comstock, Second Cornell Report, 1883), the scaly hairs in that species are "unusually numerous—seventeen on one side and twenty on the other": evidently a terminal fringe. I must remark that no species of *Diaspis* hitherto described has less than five groups of spinnerets, except *D. zamiæ*, Morgan (Ent. Mo. Mag., Feb., 1890), which has none at all. *Parlatoria* appears to have always four. On the whole, I shall leave this insect at present in the genus *Diaspis*, subject to future correction.

Genus MYTILASPIS, Targioni-Tozzetti.

Mytilaspis casuarinæ, sp. nov. Plate XI., fig. 7.

Female puparium snowy-white, convex, elongated, narrow; length, about $\frac{1}{11}$in. Pellicles terminal, orange-red.

Male puparium narrow, elongated, flatter than that of the female, but with no sign of carination; colour greyish, pellicle yellow. Length about $\frac{1}{20}$in.

Adult female brown, elongated; length about $\frac{1}{20}$in. before gestation. Abdomen exhibiting a median depression, the median lobes being represented by thickening of the margin; margin on each side much crenulated, and bearing four or five short hairs far apart. The spinnerets are very numerous, both single and in groups; but I have not been able to make out clearly whether there are five groups or an arch.

Adult male unknown.

Hab. In Australia, on *Casuarina* sp. Specimens from Mr. Koebele.

The non-carinated male puparium separates this species from *Chionaspis*, and the absence of a terminal fringe from *Leucaspis*.

Genus LEUCASPIS, Targioni-Tozzetti.

This genus resembles *Mytilaspis* very closely as far as the form of the puparium is concerned, and the only distinguishing character of the female insect is the presence of a fringe of spines on the abdominal extremity. As a similar fringe is considered sufficient to separate *Parlatoria* from *Aspidiotus*, I presume that it must be sufficient also in this case, and I shall not attempt to disturb Targioni's arrangement.

Leucaspis cordylinidis, sp. nov. Plate XI., figs. 8, 9.

Female puparium rather convex, narrow, elongated, and straight; colour white; pellicles terminal, small, greenish-

brown. Length of puparium about $\frac{1}{18}$in. Frequently covering the leaves of the plant in immense numbers.

Male puparium similar, but smaller.

Adult female brown, elongated; length about $\frac{1}{25}$in. Abdomen ending in a single median lobe, which is broader than long, and minutely crenulated on the posterior edge; at each side of this are two small conical lobules. Margin of abdomen divided into numerous minute teeth, some of which have single points, while others appear to be double; all bear short hairs, forming a fringe. Spinnerets in a continuous arch with very numerous orifices (more than a hundred); and some scattered single circular spinnerets.

Adult male unknown.

Hab. In Australia, on *Cordyline* sp. Mr. Olliff has sent me specimens from Sydney.

The only other Diaspid exhibiting a broad median terminal lobe is, I think, *Chionaspis quercûs*, Comstock (Agric. Rept., 1880, p. 319). The two European species of *Leucaspis*, *L. signoreti* and *L. pini*, have no terminal lobes at all. This Australian insect is not to be confounded with *Mytilaspis cordylinidis*, Mask., a New Zealand species, which it resembles somewhat in outward appearance. Not only do the greenish-brown pellicles distinguish it, but also the abdominal extremity of the female. The male puparium of *Fiorinia stricta*, Mask., is also similar in outward appearance, but of course the female of that species is entirely distinct.

Genus Chionaspis, Signoret.

Chionaspis brasiliensis, Signoret. Essai, p. 126. Plate XI., figs. 10–13.

Female puparium reddish-brown, flat, thin, broadly pyriform; length about $\frac{1}{20}$in. Pellicles terminal, yellowish-brown, small in comparison with the rest of the puparium.

Male puparium white, narrow, very distinctly carinated, much smaller than that of the female; length three or four times the breadth.

Adult female brown, distinctly segmented, the two last distinct abdominal segments bearing a few spiny hairs. Abdomen ending in two very minute and inconspicuous lobes; the margin is crenulated, and bears at each side three or four spines. Five groups of spinnerets; upper group with 6 to 10 orifices, lateral groups with 14 to 20.

Adult male very small, yellow; length, exclusive of the spike, about $\frac{1}{80}$in.; the spike is about as long as the abdomen. Antennæ of ten joints, with longish hairs. Feet also rather pubescent; there seem to be only two digitules, one on the claw and one on the tarsus.

Hab. In Australia, on *Orchid* sp., Tweed River; specimens sent by Mr. Koebele and Mr. Olliff. In Ceylon, on "cultivated fern"; specimens from Mr. E. E. Green, through the Indian Museum, Calcutta.

The resemblance between this and Signoret's species is so close that I do not hesitate to identify it as such. The characteristic features of the female are the reddish-brown puparium, the extreme smallness of the two abdominal lobes and the smallness of the pellicles. The male (now for the first time discovered) is remarkable for its small size and for the two digitules of the foot: I am obliged to Mr. Green for drawing my attention to this character. The species is very near to *C. theæ*, Mask. (Indian Museum Notes, vol. ii., p. 60), differing chiefly by the greater proportional length and more solid texture of the male puparium.

Chionaspis citri, Comstock. 2nd Cornell Report, 1883, p. 100. Maskell, N.Z. Trans., vol. xvii., 1884, p. 23.

Mr. Koebele brought to me from the Island of Tonga, South Pacific, some twigs of *Citrus* thickly covered with this species. I had already reported it as occurring in New Zealand. I observe that the aborted antennæ of the adult female of *C. citri* are rather more conspicuous than in other *Diaspidinæ*, and each of them bears two rather strong, curved, short setæ. The "ridge" on the puparium mentioned by Comstock is not well marked in these Tongan specimens; nevertheless, as the pygidium of the female (a much more important character) is identical, I do not hesitate as to the species. Mr. Olliff has sent me a twig of "mandarin orange" from Sydney covered with hundreds of males and a much smaller number of females; and in these last the ridge is conspicuous.

Chionaspis eugeniæ, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 14.

I have received from Mr. French some insects which I consider as only a variety of this species. They resemble the type in all characters, except that the abdominal margin bears more spines—seven or eight at each side instead of four, and in one specimen examined ten on each side. Possibly also the pellicles are of a deeper orange colour, but that is of no importance.

Hab. On *Eucalyptus*, var. sp., Goulburn, Victoria.

Genus FIORINIA, Targioni-Tozzetti.

Fiorinia camelliæ, Comstock, 1880. *Uhleria camelliæ*, Comstock, 1883.

I reported this insect last year (vol. xxiv., p. 16) as occurring on palms in Australia. Since then I have obtained

several males, and subjoin their description, which is not given by Comstock.

Male puparium white, narrow, flattish, indistinctly carinated; length about $\frac{1}{30}$in.

Adult male yellow, of the normal Diaspid form; length of body about $\frac{1}{50}$in. Antennæ of ten joints. The abdominal spike is almost as long as the body of the insect.

My specimens are from Mr. Koebele, on palm, Australia, and also on *Leptospermum* sp., growing apparently close to the palms.

Fiorinia syncarpiæ, sp. nov. Plate XI., figs. 14, 15.

Females not excreting any definite and separate puparium, but congregated in numbers under a general mass of thin, whitish, curling, cottony threads, in which the yellow oval pellicles appear scattered. The two pellicles form an elliptical, somewhat convex, scale; length of second pellicle about $\frac{1}{50}$in. When viewed by transmitted light it is seen that at each end of the oval scale there are antennæ and a rostrum; it would seem, therefore, that in the metamorphosis from the larval stage the insect becomes reversed, and also that the second-stage female preserves her antennæ. No abdominal lobes are to be made out on the second pellicle.

Male puparium rather more definitely formed than that of the female; form subcircular, flattish, consisting of loose white cottony fibres; average diameter about $\frac{1}{30}$in. Pellicle of larva central, yellow.

Adult female brownish-yellow, elongated; length about $\frac{1}{70}$in. Abdominal margin deeply serrated and irregular, terminating in two conspicuous median lobes separated by a depression, with one smaller lobe on each side. The median lobes are prolonged into scaly processes with deeply-serrated extremities, and on the other lobes, and here and there on the margin, are smaller similar scales, and also a few spiny hairs; the whole abdominal region has thus a very irregular and jagged outline. No groups of spinnerets, but a few scattered single ones. The rostral setæ are very long, and consist of six separate tubes.

Male pupa elongated-oval, the abdomen terminating in two median rectangular lobes with foliated extremities, and one very small lobule at each side; several scaly hairs on the margin. Towards the end of the pupal stage the rudimentary eyes, antennæ, and wings may be detected in process of formation.

Adult male brown, presenting no special features; length of body about $\frac{1}{40}$in. The abdominal spike is rather more than half as long as the body.

Hab. In Australia, on *Syncarpia laurifolia.* Sent by Mr. Koebele.

I attach this insect to the genus *Fiorinia* because the second female pellicle is so much larger than the adult; at the same time, if the female puparium is to be considered as probably similar to that of the male, or subcircular, it would rather be an *Aonidia.* It presents some curious characters, notably the "double-ended" pellicles and the peculiar abdominal extremity of the female, and the loose cottony threads in which the insect lives, instead of under a puparium. I do not know any other species which exhibits so many tubes in the rostral setæ.

Genus PARLATORIA, Targioni-Tozzetti.

Parlatoria proteus, Curtis.

This species occurs plentifully on some twigs of apple sent to me from Brisbane, Queensland, by Mr. Koebele. Although there is much difficulty in separating the species of this genus, yet I think my identifications are correct, as I have made careful comparison of all those hitherto described. *Parlatoria* appears to be chiefly found in hot countries—at least, out-of-doors, the insects belonging to it in cold climates being always mentioned as under glass or on tropical plants.

Group LECANIDINÆ.

Subdivision LECANODIASPIDÆ.

Genus INGLISIA, Maskell.

Inglisia foraminifer, sp. nov. Plate XII., figs. 1–5.

Test of adult female very convex, elliptical; reddish-brown at the base, fading to yellowish towards the apex; glassy and brittle; conspicuously striated from apex to base with air-cells; length averaging $\frac{1}{18}$in., but one specimen seen reached $\frac{1}{8}$in. A slightly-elevated ridge runs longitudinally from each end, widening a little towards the apex, where there is a deep transverse depression, with often an orifice at the centre through which the body of the insect can be seen. Frequently the interrupted median ends of the ridge project slightly over this depression. The test is very apt to split in two along the line of the longitudinal ridge. There is often visible a whitish fringe of short irregularly-semicircular segments, not set close together, along the basal margin, but this fringe is by no means constant.

Test of male glassy, yellow, convex, brittle; form irregularly elliptical, tapering slightly posteriorly, but cut off rather abruptly at the abdominal extremity by a flat hinged plate which the insect lifts up for egress. The apex consists of a subrectangular region, which is sometimes smooth, sometimes

transversely striated, and separated by a shallow depression from the sides, which are conspicuously striated to the base. Length of test about $\frac{1}{17}$in.

Adult female filling the test. Colour a rich dark-brown, fading to orange towards the edges. At gestation the undersurface becomes concave. On the dorsal region there is a central depression corresponding with that of the test, and a longitudinal ridge whose median ends project over the depression. Antennæ, thick, conical, with six short joints, the first and sixth being rather longer than the others. Feet very small and inconspicuous, almost atrophied, the femur, tibia, and tarsus apparently confused, with a very small short claw. Mentum doubtfully dimerous. Along the basal margin is a row of short thick conical spines, with four rather longer spines opposite the thoracic spiracles; and a similar row of short spines runs longitudinally along the middle of the dorsum. Abdominal cleft conspicuous; the lobes large, acuminate, setiferous; anogenital ring with many hairs.

Larva not observed; but under some of the females were eggshells, so that the insect is probably not viviparous.

Adult male unknown.

Hab. In Australia, on *Santalum acuminatum*. Mr. Tepper has sent me a number of specimens from Semaphore, near Adelaide.

This is an extremely pretty little species, and the forms and colours of the male and female tests are very elegant. It is the first of the genus which I have had from anywhere outside New Zealand; the Lecanid characters and the glassy striated test fix its position quite clearly. I am unable to conjecture what may be the meaning or use of the peculiar depression both in the female insect itself and in the test; the male test shows no sign of it, but the depression is constant in all the females observed—perhaps nearly a hundred.

Genus Ceroplastes, Gray.

Female insects covered with waxy tests, which present, in the adult state, no radiating marginal processes or marginal fringe, but exhibiting in the earlier stages tuberosities or projections which usually coalesce at maturity.

Male unknown.

Ceroplastes rubens, sp. nov. Plate XII., figs. 6–10.

Test of adult female waxy, rather thick, dull-red or pinkish throughout; form subcircular, quite flat beneath, with an orifice for attachment to the plant, the upper surface with irregular sloping sides and flattish top, in the centre of which there is sometimes a minute indistinct orifice; from the orifice very faint lines may be made out in some specimens, radiating

to the margin; and the lateral irregularities may sometimes be resolved into seven or eight indistinct tuberosities. Diameter of test variable: specimens observed range from $\frac{1}{11}$in. to $\frac{1}{4}$in.

The test of the second stage appears to be similar to that of the adult, but smaller; it is very difficult to make out the lateral tuberosities, which sometimes seem to be only five.

Test of the larva in its latest period before the first metamorphosis whitish, waxy, stelliform, having usually eight lateral radiating processes and a dorsal convex mass of wax: average length of the whole about $\frac{1}{40}$in.

Adult female extracted from the test yellowish-brown or dark-brown; subcircular, convex above and concave beneath; form normally *Lecanid;* anal cleft small, lobes triangular, each bearing a short seta; anal ring with six strong hairs. At the cephalic extremity there is a dorsal elevation or tuberosity, which bears several small subconical papillæ. Antennæ of six joints, of which the third is much the longest. Feet nearly atrophied, short, thick; tarsus very short, claw small, digitules slender knobbed hairs. Rostrum rather large; mentum monomerous. On the margin, near the four spiracles, is on each side a patch containing one large thick conical spine and about twenty other smaller ones. Dorsal epidermis bearing some small circular spinneret-orifices.

Larva dark-yellow, flattish, elongated, distinctly Lecanid. Eyes large, brown. Antennæ of apparently six joints, but the fourth and fifth are not easily separable. Length of insect in this stage about $\frac{1}{80}$in. at first, increasing to about $\frac{1}{50}$in. with age.

Male unknown.

Hab. On *Mangifera indica* (mango), and on *Ficus* (*F. macrophylla ?*), the Moreton Bay fig, Brisbane, Australia. Mr. Koebele sent me several specimens.

I have ventured to consider this as a new species, although I am not sure that it is not at least closely allied to *C. myricæ*, Linn., a species originally from the Cape of Good Hope on *Myrica cerifera;* and, indeed, my first idea was to attach it to that species, the latest description of which (as far as I know) is given by Fabricius (Ent. Syst., 1794, iv., 227). But, after careful consideration, I find that *C. myricæ* is not only white in colour towards the edges (the centre being reddish), but also convex—"vertice obtuse acuminatus"—and that the margin bears seven distinct tuberosities. The flat vertex and agglomerated margin of *C. rubens* do not answer to such a description, and I therefore place it as a separate species, subject of course to future correction.

The wax of *C. rubens* dissolves readily in potash: on cooling it recoalesces, and I have always found it lose its red colour and become white.

Ceroplastes ceriferus, Anderson. Plate XII., figs. 11–16.

Test of adult female white or yellowish-white, waxy, convex, thick; frequently agglomerated in large masses covering the twigs of the food-plant. Separate individuals may range in size from $\frac{1}{5}$in. to $\frac{1}{2}$in. Marginal tuberosities not distinguishable, though the margin is sometimes slightly flattened and irregular. The apex of the test is sometimes produced in a short pointed horn, not erect, but bent over the test. The wax is rather soft and greasy.

Test of the second stage slightly convex, elliptical; colour greyish-white; median dorsal region usually smooth, separated by a shallow depression from the marginal region, which exhibits eight tuberosities, three on each side and two terminal. Average length of test about $\frac{1}{7}$in.

Adult female brown, very convex, elliptical, hollow beneath. Form Lecanid; but the anal cleft and lobes are not easily made out, being contained in a conspicuous cylindrical "tail," or prolongation of the abdomen. Antennæ of six joints, of which the third is much the longest. Feet rather thick, but not at all atrophied; tibia scarcely longer than the tarsus; upper, or tarsal, digitules slender knobbed hairs, lower pair on the claw rather long, thick, and expanded at the end. Rostrum rather large; mentum doubtfully dimerous. Near the spiracles, on each margin, is a group containing eight large conical spines and about twenty-four smaller ones. Epidermis bearing many circular spinneret-orifices. When the "tail" is subjected to the action of potash and subsequent pressure it is seen to contain at its extremity the abdominal lobes and the anogenital ring, which has six rather strong hairs.

Female of the second stage brown, elliptical, slightly convex. Form Lecanid, exhibiting the normal cleft and lobes; there is no "tail," but the region surrounding the lobes is thickened. Antennæ and feet as in the adult, but the feet are more slender. The margin bears a row of fine spiny hairs, and four spiracular groups of large conical spines. There are many small circular spinnerets on the epidermis.

Larva yellow, elliptical, flattish; length about $\frac{1}{70}$in. Form normally Lecanid, the anal lobes bearing long setæ. Antennæ thick, with six rather confused joints.

Male unknown.

Hab. In Australia, on *Melaleuca hypericifolia*, *Myrica cerifera*, and other plants; in India, on *Celastrus ceriferus*, and on the Assam tea-plant, Kangra Valley. My Australian specimens were sent to me by Mr. Koebele and Mr. Olliff; the Indian ones are from Mr. Cotes.

I have given a detailed description here of this insect

because, although it was first made known by Dr. Anderson in 1790–91, and mentioned since that time by several writers —including Westwood, 1853, and Signoret, 1872—all of these appear to have confined their attention to the waxy tests, and I am not aware that the insect itself has ever yet been fully described. Signoret merely says that it is subglobular, and slightly prolonged posteriorly. Fourteen species of *Ceroplastes* from different countries have received names, but probably several of these are really identical: *e.g.*, *C. chilensis*, Gray, and *C. vinsonii*, Sign., and others, may all be really *C. ceriferus*. The only species in which the adult females have been reported hitherto as exhibiting a prolongation of the abdomen are *C. ceriferus*, *C. psidii*, Chav., *C. cassiæ*, Chav., *C. fairmairei*, Sign., and *C. cirripediformis*, Comstock (an American insect), and all these also have nearly similar conical spiracular spines. I am not sure whether all the last-named species may be really distinct or not.

Mr. Cotes, in the "Indian Museum Notes," vol. ii., No. 3, 1891, gives an excellent account of the wax of this species, and seems to think that the insect is not very common in India. It may, however, be an inhabitant of many tropical or subtropical countries. From Mr. Cotes's account I gather that the wax is not likely to have much commercial value, even if it could be produced in large quantities.

Since writing the foregoing I have more carefully studied Signoret's description of *C. fairmairei*, Targioni (1858), a species from Montevideo, and also his figures, especially of the spiracular spines, and I have come to the conclusion that this species is identical with *C. ceriferus*. The dermal spots and markings shown in Signoret's plate ix., fig. 7, may be faintly detected in some of my Australian insects—early adults—and the other characters also agree. On the whole it seems probable that several species of *Ceroplastes* may be considered as synonyms of Anderson's insect, which was first described in 1791.

Subdivision LECANIDÆ.

Genus LECANIUM, Illiger.

Lecanium baccatum, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 20.

Mr. J. G. O. Tepper, in a letter to me, says, "In South Australia these insects in a young state, yet nearly full-grown, are always of a pure bluish-white, which with advancing age becomes yellowish. The species, though not exactly rare, has been always local, and the various colonies, affecting a single branch or bush, are usually at considerable distances apart."

Lecanium hesperidum, auctorum.

Mr. Douglas and Mr. Newstead, in the Ent. Mo. Magazine for September, 1891, p. 244, make some observations regarding this species and its distinction from *L. lauri*, Boisduval. They give a comparison between the two, based on certain differences observed in the feet, for, as they remark, "the antennæ in both kinds do not appreciably differ." Dr. Signoret (Essai, p. 230) expressed doubts whether the two were not really identical, but the conclusion of Messrs. Douglas and Newstead is that the characters of the feet are sufficiently distinct to separate the two species.

In one of the numbers of "Insect Life" (I cannot just now mention the particular number) Professor Riley asked the question whether the true *L. hesperidum* exists in New Zealand. The question only came in incidentally, if I recollect aright; but presumably its meaning was that probably our New Zealand form might be *L. lauri;* and, considering that it occurs here upon a large number of plants, notably ivy, holly, and the different kinds of *Laurus*, and that citrus trees are uncommon in the colony except in the North, the question was a very natural one.

Mr. Koebele sent to me from Sydney, early in the present year, some leaves of orange infested by a scale very closely resembling *L. hesperidum*, but larger and lighter-coloured than our New Zealand form; and Mr. Olliff later on sent twigs of the same plant infested by the same scale. I have taken the opportunity of comparing carefully the Australian and the New Zealand forms, and the result is that I am unable to establish a sufficient specific difference between *L. hesperidum* and *L. lauri*. I take no account of size or colour in the two—the rich juices of citrus naturally, as I think, induce the insects feeding thereon to be larger and handsomer than those on the hard food of holly or ivy—but I have confined myself to the characters of the feet. I find that the characters as tabulated by Mr. Newstead (Ent. Mo. Mag., Sept., 1891, p. 245) are indiscriminately noticeable both in my specimens (five) examined on citrus, and in the specimens (eight) examined on holly, laurel, &c. Thus, the Australian specimens have short tarsal digitules, two fine terminal tarsal hairs, two coxal hairs—characters of *L. lauri;* and one very long hair on the trochanter—a character of *L. hesperidum*. The New Zealand specimens have long tarsal digitules, a long trochanter hair, and coxa hairless—characters of *L. hesperidum;* and two terminal tarsal hairs—a character of *L. lauri*.

The conclusion, therefore, would seem to be that either *L. hesperidum* lives on laurel, ivy, holly, and other plants in New Zealand, whilst *L. lauri* attacks citrus in Australia—thus

reversing the European arrangement—or else the two species are identical. The latter alternative is that which induced me to report *L. hesperidum* alone in 1878 and 1887 in New Zealand, and which seems to me still to be correct.

Lecanium tessellatum, Signoret. Sign., Essai, p. 231. Plate XIII., fig. 1.

This insect, which, from its flatness and viviparous habit, belongs to Signoret's first series of the genus, is characterized especially by "a marquetry pattern on the epidermis, in which each separate section is unlike the one next to it, but quite similar to the similarly-situated section on the opposite side." Each side, therefore, of the body seems quite irregularly marked, but the two sides are symmetrical. The insect is reddish-brown, flat, rather acuminate anteriorly and broadly rounded posteriorly. The markings are not to be clearly made out until after treatment with reagents. Length about $\frac{1}{8}$in.

Hab. In Australia, on *Laurus nobilis*, Sydney. My specimens are from Mr. Koebele. Signoret reports the insect as on palms in hothouses in Europe.

Lecanium acuminatum, Signoret. Sign., Essai, p. 227. Plate XIII., figs. 2, 3.

Adult female yellowish-brown, flat, acuminate at the cephalic extremity and very broadly rounded posteriorly. Length about $\frac{1}{8}$in. Antennæ of seven joints, of which the fourth is the longest, the fifth and sixth the shortest. Tarsus about half as long as the tibia. The epidermis bears a large number of circular marks, each with a central clear space.

Female of second stage broadly elliptical, flat, yellowish; length about $\frac{1}{30}$in. Antennæ of six joints.

Larva yellowish-brown, flat, broadly elliptical; length about $\frac{1}{80}$in.

Male unknown.

Hab. In the Sandwich Islands, on guava (*Psidium* sp.). Sent by Mr. Koebele.

I do not doubt my identification of this species. Signoret (whose specimens were on hothouse orchids in Paris) does not mention the dermal markings.

Lecanium anthurii, Boisduval. Signoret, Essai, p. 265.

I have received from Mr. French specimens of an insect on *Asparagus* sp., Melbourne, which appear to me to belong to this species, which belongs to Signoret's fourth series, being very convex, with a dermal pattern of oval marks, not conjoined, and with a median clear space in each. The colour is brown. The original species occurred in Europe on a hothouse orchid.

Lecanium filicum, Boisduval. Signoret, Essai, p. 436. Plate XIII., fig. 4.

Adult female semiglobular, with a flattened margin; colour reddish-brown; diameter about $\frac{1}{13}$in. Epidermis exhibiting regular oval markings. Antennæ of eight joints. Tarsus showing a distinct articulation with the tibia. Body frequently carinated.

Female of the second stage flattish, elongated-elliptical.

Larva yellowish, flat, elliptical. Length about $\frac{1}{70}$in.

Hab. In Australia, on a fern, probably *Lomaria* sp., Tweed River. Sent by Mr. Koebele.

Signoret (and after him Douglas) separates this species from *L. hemisphæricum*, which it very closely resembles, by the carinations of the dorsum. I am not sure, however, that the distinction is quite satisfactory. The frond of fern which I received was covered with great numbers of individuals, and whilst some of them exhibited carinations others did not. It is not likely that the two species are mingled on the plant, and, as about half the specimens were not quite smooth, I have felt compelled to place them as *L. filicum.*

Lecanium depressum, Signoret. Sign., Essai, p. 269.

Adult female reddish-brown, darkening with age to nearly black; form elliptical, more or less convex; length variable from $\frac{1}{8}$in. to $\frac{1}{4}$in. Antennæ of eight joints, of which the third is the longest. Feet rather long; tarsus almost as long as the tibia. Epidermis marked with many cells of irregular shape, closely conjoined and forming a "marquetry pattern"; in the middle of each cell is a small oval clear spot. At the very latest stage, when the insect is darkest in colour, the cells cannot be seen until after treatment with potash.

Female of the second stage light-brown, flattish, elliptical; length about $\frac{1}{16}$in. Antennæ of six joints. Dorsum frequently, but not always, exhibiting one longitudinal and two transverse carinæ.

Larva brown, flat, elliptical; length about $\frac{1}{50}$in. Antennæ of six joints.

Hab. In New Zealand, not common, on various greenhouse plants; in Australia, on *Hakea* sp., on "cultivated vine," and on an unnamed plant, Sydney and Tweed River; and in the Sandwich Islands, on *Psidium* (guava) and *Bambusa* (bamboo). Mr. Olliff sent it to me on *Hakea*; my other exotic specimens are from Mr. Koebele.

I reported this insect in New Zealand in 1878, and after examination, and comparison with the Australian and Sandwich Islands specimens, I have no doubt of its identity. Signoret was the first to describe it in detail, although Targioni had previously given it its name. In Signoret's description he

says that, whereas his specimens in hothouses at Paris exhibited dorsal carinæ, those from hothouses in Italy had dorsal depressions. It is clear that in this respect the insect varies, and the dorsal marquetry is really the distinguishing character of it. Targioni's name—*L. depressum*—must, of course, be retained, though the feature to which it refers is of no value. Mr. Douglas reports the species (Ent. Mo. Mag., 1887, p. 28) in England on *Ficus*. The second stage and larva have not been described hitherto.

Lecanium longulum, Douglas; *Lecanium chirimoliæ*, Maskell, 1889.

This insect occurs in the Sandwich Islands, and is there apparently common; for Mr. Koebele brought me thence several plants upon which I found it plentiful—*e.g.*, *Psidium*, *Bambusa*, *Acacia*, *Citrus*, and several unnamed.

I mentioned in 1890 my conviction of the identity of this species with mine from Fiji; and comparison with these specimens from Honolulu confirms that opinion.

Lecanium scrobiculatum, sp. nov. Plate XIII., figs. 5–7.

Adult female brownish-yellow, elliptical; very convex in the median region and slightly flattened towards the margins, having thus a sort of dorsal "hump"; length about $\frac{1}{18}$in. Epidermis rough, with a network of minute wrinkles on the flatter portions, forming small cell-like divisions; smoother on the dorsal convexity, but marked there with many very minute pit-like depressions. Antennæ of seven joints, of which the third and fourth are the longest, and about equal to each other. Feet rather thick; tarsus as long as the tibia; claw very small; all the digitules appear to be very short. On the margin of the body is a row of small spiny hairs, not set close together. At each of the four spiracular depressions of the margin is a chitinous semicircular band, which bears some short club-shaped spines. Abdominal cleft small; lobes large, conical, setiferous; anogenital ring with many hairs.

Female of the second stage yellow, elliptical, flattish, but with a raised median longitudinal ridge; length about $\frac{1}{18}$in. Epidermis wrinkled as in the adult, but the pits on the median region are not noticeable. Antennæ of six slender joints; the third and fourth joints in the specimens observed were very long and thin. Feet normal. Spiracular spines long. A row of spiny hairs runs round the margin of the body.

Larva not observed.

Male pupa covered with a white, thin, glassy, elongated test, very shiny and brittle. Many of the specimens observed enclosed hymenopterous parasites, the pupæ of which, showing

through the nearly transparent test, made the latter look almost black. Length of test about $\frac{1}{18}$in.

Adult male dark-orange or red in colour; length, exclusive of spike, about $\frac{1}{30}$in. Antennæ of ten joints. Dorsal eyes four, ventral eyes two, ocelli two. Wings brightly iridescent, with strong red nervures. Abdominal spike rather thick at the base, slightly curved, and nearly as long as the abdomen.

Hab. In Australia, on *Acacia* sp., Whitton, New South Wales. Specimens from Mr. Koebele.

This insect belongs to Signoret's second series of the genus, being convex, with (at least, in the second stage) a dorsal longitudinal carina. I cannot identify it with any known species. The male, with its bright wings and their red nervures, is an elegant little insect.

Genus PULVINARIA, Targioni.

Pulvinaria dodonææ, sp. nov. Plate XIII., figs. 8, 9.

Adult female reddish-brown, darkening with age. Before gestation the form is regularly elliptical, flattish or slightly convex, and has the appearance of a full-grown *Lecanium;* as the white cottony ovisac is formed the insect shrivels, becoming corrugated and irregular in outline, and at the last appears only as a small brown speck at the end of the white cottony sac. The size therefore varies, some individuals observed before gestation reaching $\frac{1}{8}$in., while the females after gestation average only $\frac{1}{20}$in. The ovisac averages about $\frac{1}{3}$in. in length, and is of the normal subcylindrical form. Antennæ of eight joints, of which the third is the longest, the last four the shortest and equal to each other. Feet rather long and slender; the tibia is about twice as long as the tarsus, which is slightly curved; the tibia is somewhat expanded at its end; lower digitules long and expanded, upper pair fine hairs. There is a row of spiny hairs round the margin of the body, set rather close together. Abdominal cleft narrow; lobes rather long; anogenital ring with several hairs. Mentum monomerous. Epidermis with great numbers of spinneret-orifices, principally on the abdominal region.

Female of the second stage regularly elliptical, very slightly convex, smooth; colour greenish-yellow; length about $\frac{1}{12}$in. Antennæ of six joints. Feet as in the adult. This stage is frequently parasitized.

Larva yellowish-brown; flattish, elliptical; length about $\frac{1}{70}$in. Antennæ of six joints, subequal except the last, which is a little longer, and bears some hairs of which two are rather long. Abdominal setæ long.

Male pupa covered with a white, glassy, elongated test, with sides and ends sloping, and the top covered with a flat

plate of secretion. Length of test about $\frac{1}{13}$in. The insect escapes by lifting up the posterior end.

Adult male unknown.

Hab. In Australia, on *Dodonæa bursarifolia* and *Myoporum* sp. My specimens are from Mr. Tepper.

The variations in size and colour of this insect render it difficult to identify. Not only is the adult before gestation lighter in colour and much larger than the adult after gestation, but the greenish second stage is not at first sight much like either, and, indeed, has sometimes rather the appearance of some species of *Planchonia.* However, when a number of individuals are observed in which the commencement of the ovisac can be detected behind the large adults, and when the anatomical characters given above are constant in all stages, the adults and the younger individuals being all mingled together on the plant, it is evident that all are really the same species.

Pulvinaria psidii, sp. nov. Plate XIII., figs. 10, 11.

Adult female yellow, or yellowish-brown, sometimes with a greenish tinge; size variable, reaching $\frac{1}{12}$in. before the ovisac is formed, but shrivelling at gestation. The ovisacs cover the twig or leaf with masses of dirty-white cotton, usually accompanied by black fungus. Antennæ rather long and slender, of eight joints, of which the third is the longest, the eighth next, the rest shorter and subequal. Feet also rather long; the trochanter is large and bears a very long hair; tarsus curved and about half as long as the tibia; upper digitules fine hairs, lower pair long and dilated at the end. Abdominal cleft moderate; anogenital ring with several hairs. The margin of the body bears a row of spiny hairs.

Female of the second stage yellow, flattish, elliptical; length about $\frac{1}{20}$in. Antennæ of six joints.

Larva yellow, flat, elliptical. Antennæ of six joints.

Male unknown.

Hab. In the Sandwich Islands, on *Psidium* (guava). My specimens are from Mr. Koebele.

This species appears to differ in the feet and antennæ from any of those hitherto described. From the look of the twigs and leaves which have been furnished to me I should imagine that the insect must be rather damaging; at all events, the masses of greyish ovisacs are very unsightly.

Genus SIGNORETIA, Targioni.

Signoretia luzulæ, Dufour. Signoret, Essai, p. 181. Plate XIII., figs. 12, 13.

I have received from Mr. Olliff some specimens which I propose to attach to this species. The adult females are

yellowish-brown, enclosed in a narrow elongated convex sac of pure-white cotton so closely felted as to seem rather solid; and this sac is quite identical (except in size) with my type-specimens of *S. luzulæ* from Europe. In size it is about twice as large as the type, but I do not consider that as important. The enclosed female is, before gestation, of the normal length, about ⅛in.; but shrivels considerably at gestation. The antennæ have eight joints, of which the third and fourth are the longest. Signoret makes the fourth and fifth longer than the rest, but Mr. Newstead shows (Ent. Mo. Mag., May, 1892) that this is an error. The digitules of the claw are very large and widely dilated. The margin of the body bears some small spines, and the epidermis is covered with a great number of tubular spinnerets.

Hab. In Australia, on grass, Nevertire, New South Wales.

At first sight I thought that this would turn out to be a Dactylopid, probably *D. herbicola* or *D. graminis*, Mask.; but it is very clearly a Lecanid in all its characters. It would have been easy for me to erect it into a new species on the size of the sac and on some very minute differences which may be detected in the antennæ both of the adult and the larva; but I greatly prefer, wherever it is at all possible, to avoid the multiplication of species. Perhaps a character mentioned by Signoret, and apparent also in this Australian form, may also be conclusive as to the identity: it is that the sac has a small orifice at one end, which is closed by the body of the insect.

Genus PROSOPOPHORA, Douglas. Ent. Mo. Mag., Aug., 1892, p. 207.

Adult female covered with a test which is either waxy or so closely felted as to appear almost homogeneous. Margin of test without fringe. Antennæ of not more than eight joints. Anal tubercles present, but in the species observed very small. Anogenital ring with more than eight hairs. Feet usually atrophied. Mentum usually monomerous. There is generally a small terminal orifice in the test.

Male pupa covered with a test of similar material to that of the female; antennæ of adult with ten joints.

Larva exhibiting anal tubercles; abdomen not cleft.

In the foregoing diagnosis I have somewhat extended and less definitely fixed some of the generic characters originally laid down by Mr. Douglas, in order to attach to this genus two Australian species which, with these alterations, will sufficiently agree with it. I have been in great doubt as to the genus to which they might belong, and, although in a few respects they approach *Planchonia*, yet in others they differ from it. If, on the other hand, I left Mr. Douglas's charac-

ters exactly as he stated them, my species would not come quite into *Prosopophora:* for example, he says, "Surface with granulose raised lines; no anal cleft or tubercles." But the first of these is of no generic importance whatsoever; it may be a fair specific character: the second is manifestly not quite correct, as in his fig. 1*f* he shows two distinct tubercles. It is therefore not only convenient, but even necessary, to somewhat amend the generic characters; and this being done I can avoid the danger of overloading the study of Coccids with a new genus founded upon insufficient distinctions.

Mr. Douglas, having seen only one species, expresses much doubt as to the group in which *Prosopophora* should be placed. My two Australian species (or varieties) clearly show it to be Acanthococcid, and not far removed from *Planchonia:* indeed, I have hesitated long before separating it from that genus. There seems, indeed, to be no marginal fringe on the test or sac; but the adult female exhibits figure-of-eight orifices which, though much smaller, resemble those of *Planchonia epacridis.*

Prosopophora acaciæ, sp. nov. Plate XIV., figs. 1–7.

Adult female covered by a waxy test; test elliptical, slightly convex, smooth, yellowish-brown; length about $\frac{1}{7}$in.; margin irregular, but without fringe; there is a small orifice at the posterior extremity. When the test is lifted up the portion of the twig immediately beneath is seen to be depressed and concave, and the space so formed is usually filled with eggs or eggshells.

Male pupa covered by a white, waxy, elliptical test; length of test about $\frac{1}{23}$in. Anterior portion of test smooth, the posterior region transversely corrugated.

Adult female brown, filling the test, but shrivelling at gestation. Antennæ very short, rather thick, with apparently only four joints, but the joints are much confused, and there may be six; the last joint bears a few hairs. Feet atrophied, very small and thick, the tibia and femur confused, the tarsus very small and very short, followed by a minute claw; digitules probably absent. Anal tubercles moderate, each bearing two or three spiny hairs. The epidermis bears a great number of tubular cylindrical spinnerets, and many very minute figure-of-eight orifices. On the margin there are a few conical spines and a double row of very small figure-of-eight orifices.

Female of the second stage brown, flattish, elliptical; length about $\frac{1}{30}$in. Antennæ of six rather thick joints. Anal tubercles large, converging at the extremity so as almost to exhibit an abdominal cleft, but close examination shows that there are no dorsal lobes, and that the abdomen is not Lecanid; on each tubercle there is a long terminal seta.

Larva brown, flattish, elliptical; length about $\frac{1}{80}$in. Antennæ of six joints. Anal tubercles distinct.

Adult male unknown.

Hab. In Australia, on *Acacia calamifolia.* My specimens are from Mr. Tepper.

In the Ent. Mo. Mag., November, 1890, I asked the question, How do Coccids produce cavities in plants? And amongst other instances I mentioned a New Zealand species, *Ctenochiton viridis,* which formed beneath it on its leaf a depression. That insect does its work on soft leaves; *Prosopophora acaciæ* (as well as the next species to be described) lives on twigs of very hard wood; yet it hollows them out somehow, and I cannot discover how the process is effected; for there is no swelling of the bark, or distortion of the twig, or wound of the tissues noticeable in the vicinity.

Prosopophora eucalypti, sp. nov. Plate XIV., figs. 8–11.

Adult female covered by a test which is very closely felted, but which is seen, on careful examination, to be not perfectly homogeneous wax; colour of test yellowish-brown, but frequently covered with black fungus; form subcircular, flattish at the top, rather thick; there is a small orifice in the posterior region. There is a depression in the twig beneath, as in the last species, filled with eggs. Diameter of test about $\frac{1}{13}$in.

Test of male pupa white, or grey, or yellowish; texture more waxy than that of the female, but not solid; anterior portion smooth, posterior region transversely corrugated. Length about $\frac{1}{25}$in.

Adult female brown or red, filling the test, but shrivelling at gestation. Antennæ moderately long, of six joints, which sometimes appears to be eight, as there are "false joints" in the third and the sixth; these two joints are consequently rather the longest. Feet completely atrophied. Anal tubercles small. Epidermis bearing great numbers of tubular spinnerets and of minute figure-of-eight orifices.

Female of the second stage brown, flattish, elliptical. Length about $\frac{1}{25}$in. Antennæ of six rather thick joints. Anal tubercles large and converging, as in the last species, thus simulating an abdominal cleft.

Larva light-brown, flattish, elliptical. Length about $\frac{1}{50}$in. Antennæ of six joints. Anal tubercles large and converging.

Adult male unknown.

Hab. In Australia, on *Eucalyptus* sp. My specimens were sent by Mr. Koebele from Whitton, New South Wales.

The differences in the feet and antennæ are sufficient to separate this from the last species.

Genus GOSSYPARIA, Signoret.

Adult females lying on a cushion of cotton, the dorsum exposed. Characters of *Acanthococcidæ;* retaining feet and antennæ.

Gossyparia casuarinæ, sp. nov. Plate XIV., figs. 12, 13.

Adult female brown, varying from light to dark, elongated, convex, elliptical, resting on a cushion of grey cotton which leaves almost the whole insect exposed. Length about $\frac{1}{12}$in. Antennæ of six joints, of which the third is the longest, the fourth and fifth the shortest. Feet with the tarsus longer than the tibia (a frequent character in *Acanthococcidæ*); all the digitules are fine hairs. Anal tubercles conspicuous. Mentum dimerous. On the margin of the body a row of slender spines, not very close together.

Female of second stage not observed.

Larva brown, flattish, elliptical. Length about $\frac{1}{60}$in. Antennæ of six joints. Anal tubercles large and conspicuous. Margin of the body bearing a row of strong spines, slender, with tubercular bases. These spines are smaller on the thoracic than on the abdominal segments, and increase in length as they approach the extremity.

Male unknown.

Hab. In Australia, on *Casuarina* sp. Specimens from Mr. Koebele, from Sydney.

The cushion of grey cotton in this species is more scanty than is usual in the genus, almost the whole insect being exposed instead of only the dorsum, as is ordinary. A distinctive character of the larva appears to be the varying length of the marginal spines from the cephalic to the abdominal regions.

Gossyparia confluens, sp. nov. Plate XIV., fig. 14.

Adult females excreting a quantity of white cotton, with sometimes a yellowish tinge, aggregated in a mass on the twigs of the plant, and not entirely covering each insect, so that the twig looks as if covered with a honeycombed incrustation, in the interstices of which the bodies of the insects can be perceived. Insect dark-red in colour, subelliptical, convex. Antennæ of six joints, the first three of which are the longest and subequal, the last three short and subequal. Feet rather long; tarsus nearly one and a half times the length of the tibia. Anal tubercles conspicuous. Body covered with numerous slender spines. Mentum dimerous. Anal ring with eight hairs.

Larva and male not observed.

Hab. In Australia, on *Eucalyptus* sp. Specimens from Mr. Koebele, from Sydney.

The appearance of the mass of cotton in which this species is imbedded is rather curious. The insects seem to drop out easily.

Genus Eriococcus, Targioni-Tozzetti.

Eriococcus turgipes, sp. nov. Plate XIV., figs. 15–20.

Sac of adult female white, rather solid, very tough and leathery; form globular, but several sacs are frequently aggregated in a mass. There is in most cases an orifice on the dorsal region, but sometimes the sac is closed. Diameter about $\frac{1}{10}$in.

Sac of male pupa not certainly observed, but probably of the same material as that of the female, but smaller and more elongated; usually open at the top.

In both female and male sacs there is a small quantity of white loose cotton covering the dorsum of the insect inside the sac, and separated from it.

Adult female yellowish-brown, becoming nearly black at gestation. Form subglobular, but slightly flattened dorsally, and the median dorsal region is darker in colour than the rest. Antennæ of six joints, of which the third and the sixth are much longer than the other four. Mentum large, dimerous. Feet very thick, swollen, and partly atrophied; the coxa and femur very large; the tibia, tarsus, and claw fused into one and very small, so that when viewed from below they form a single straight subconical joint, whilst if viewed from the side they are irregular and curved; digitules absent. Anal tubercles very small, each bearing one moderate seta and a great number of short conical spines. Anogenital ring compound, with six hairs. Epidermis bearing great numbers of short fine hairs, interspersed with circular orifices and with short conical spines; the spines and the orifices are most numerous on the median dorsal region. There are also several short spines on the femur.

Female of the second stage not observed.

Larva brown, flattish; form elliptical, but only slightly elongated, so that it has a rather squat appearance; length about $\frac{1}{90}$in. Antennæ long, with six joints, of which the sixth is very long and fusiform, the second being the next longest. Anal tubercles very small, convergent, and only bearing short terminal spines instead of setæ. The rostral setæ are very long. Feet normal; lower digitules fine hairs; the tarsal pair are absent.

Adult male unknown.

Hab. In Australia, on *Casuarina* sp. Specimens sent by Mr. Koebele from New South Wales.

This is a very peculiar species, which possibly I might have rather placed in the genus *Gossyparia*, on account of the

dorsal opening in the sac; but this opening is not, I think, constant, and in no case does it reduce the sac to anything like a mere cushion. The insect is practically enclosed. The six hairs of the anogenital ring are abnormal, the generic number being eight; but, as I remarked in my paper of 1890 (vol. xxiii., p. 32), the student of Coccids must be prepared to look on any character as elastic and variable. The distinctive specific feature of *E. turgipes* is the peculiar form of the feet; and I have found in preparing a number of specimens for microscopic examination that in all cases they assumed the position shown in my figure—they radiate like spokes of a wheel, whereas in other Coccids they are naturally bent downwards. The outline of the insect being circular, the six feet are placed at equal distances, so that the anterior pair are in front of the rostrum, the posterior pair very far towards the anal tubercles. Perhaps, also, the very long sixth joint of the larval antennæ may be looked on as an exceptional character.

Eriococcus coriaceus, sp. nov. Plate XV., figs. 1–3.

Sac of adult female varying in colour from light-yellow or buff to dark-orange or red; form elliptical; sometimes single, sometimes aggregated in masses on a twig. Texture very leathery and tough. There is a small orifice at the posterior extremity. Length about $\frac{1}{15}$in.

Sac of male pupa of similar material and colours, but smaller.

Adult female dark-red, filling the sac. Antennæ of seven subequal joints, which in a few specimens seen appear like eight. Feet normal, the tibia about half as long as the tarsus. Anal tubercles moderate; anogenital ring with eight hairs. Epidermis bearing many fine short hairs and short slender spines. Mentum dimerous.

Female of the second stage not observed.

Larva red, flattish, elliptical; length about $\frac{1}{55}$in. Form normal; antennæ of six joints; anal tubercles conspicuous.

Adult male unknown.

Hab. In Australia, on *Eucalyptus* sp. Specimens from Mr. Olliff, New South Wales.

This species, in the form of its sac and in the antenna, approaches *E. eucalypti*, Mask.; but the sac has no glassy tubes on it, and the body of the insect has slender hairs instead of the thick conical spines of that species. It is viviparous, and several specimens seen were so full of lively larvæ that it seemed a wonder how these could find room.

Eriococcus conspersus, sp. nov. Plate XV., figs. 4–6.

Sac of adult female yellow, not closely felted, subglobular; diameter about $\frac{1}{20}$in.

Sac of male pupa white, cylindrical; length about $\frac{1}{40}$in.

Adult female brown; form normal; length about $\frac{1}{25}$in. Antennæ of six joints, of which the third is much longer than the rest. Feet normal; tibia about three-fourths the length of the tarsus. Anal tubercles conspicuous and large. Epidermis covered very thickly on the dorsal surface with small irregularly oval markings, which are most numerous near the margin, and with some circular spinneret-orifices.

Female of second stage not observed.

Larva brown, flattish, elliptical; length about $\frac{1}{60}$in. Antennæ of six joints.

Adult male dark-brown; length about $\frac{1}{50}$in. Antennæ of ten joints. The anal "tails" are rather long.

Hab. In Australia, on *Casuarina* sp. Specimens sent by Mr. Koebele, from Harwood, New South Wales.

The minutely-speckled epidermis of this species, which is not properly observable until properly prepared, sufficiently distinguishes it from others of the genus.

Genus Rhizococcus, Signoret.

Rhizococcus grandis, Maskell, var. **spinosior.**

Adult female of the same colour and form as the type (N.Z. Trans., vol. xxiv., p. 29), but smaller; length about $\frac{1}{8}$in. It resembles *R. grandis* in the antennæ, in the smallness of the anal tubercles, and in the characters of the larva. The principal difference is in the dorsal spines, which are more numerous; perhaps, also, the lower pair of digitules are less dilated. It would be easy, no doubt, to make a new species of it: I prefer to consider it merely as a variety, especially as the food-plants of the two belong to the same genus.

Hab. In Australia, on *Acacia implexa.* Specimens sent by Mr. J. Lidgett, of Myrniong, Victoria.

Rhizococcus casuarinæ, sp. nov. Plate XV., fig. 7.

Adult female varying in colour from yellow to dark-red; form normal, but the segments are scarcely noticeable. Length about $\frac{1}{8}$in. Antennæ of six joints, of which the third is nearly as long as all the rest together. Feet normal; tibia about half as long as the tarsus. Anal tubercles moderate, but not observable in the natural state, being hidden by the convexity of the abdomen. Dorsum bearing some slender spines, some of which are very long.

Larva red, flattish, elliptical; length about $\frac{1}{45}$in. Antennæ of six joints. On the dorsum are four median longitudinal rows of very strong and long spines, and four other rows of smaller spines, two of which are marginal.

Male unknown.

Hab. In Australia, on *Casuarina suberosa.* Specimens sent by Mr. Lidgett.

This is another species allied to *R. grandis;* but it appears to differ from that sufficiently in the antenna, and principally in the rows of very strong spines on the dorsum of the larva.

Rhizococcus pustulatus, sp. nov. Plate XV., figs. 8, 9.

Adult female dark-red in colour, convex, subelliptical and tapering somewhat posteriorly; the dorsum exhibits two longitudinal grooves on the upper surface and two others more shallow near the margins, and in these grooves are some rather large shallow depressions or pits; the epidermis is rough with great numbers of very minute pustules. Length of insect about $\frac{1}{15}$in. Anal tubercles small, but conspicuous. Antennæ short, with six joints, of which the fourth and fifth are the shortest. Feet absent. Anogenital ring with eight hairs. Mentum dimerous. The dorsal pustules are very noticeable after treatment with potash.

Female of the second stage red, subelliptical, tapering posteriorly, slightly convex; length about $\frac{1}{40}$in. Antennæ of six joints, of which the sixth is the longest. Feet normal, the tibia a little shorter than the tarsus. Anal tubercles conspicuous, with long setæ. Epidermis rough with minute pustules. Margin irregular, and bearing many slender spines.

Larva yellowish-red, subelliptical, tapering; length about $\frac{1}{70}$in. Anal tubercles moderate. Antennæ of six joints. The dorsal epidermis is profusely marked with very minute wrinkles, and these are also seen in fewer numbers on the ventral surface. The margin bears a row of small slender spines.

Male unknown.

Hab. In Australia, on *Casuarina* sp. My specimens are from Mr. J. Lidgett, of Myrniong, Victoria.

At first sight this insect might be taken for *R. casuarinæ*, or for a small form of *R. grandis;* but it is apodous, and moreover distinguishable by the dorsal corrugations, shallow pits, and minute pustules.

Subdivision DACTYLOPIDÆ.

Genus DACTYLOPIUS, Costa.

Dactylopius arecæ, Maskell. N.Z. Trans., vol. xxii., p. 150.

I have received from Mr. W. W. Smith, of Ashburton, specimens of this insect found amongst roots of gooseberry, red-clover, grass, dock, and other plants, underground. My original specimens were amongst roots of *Areca sapida.* It would appear, therefore, that the insect is not uncommon, and is not confined to any particular plant. My Ashburton speci-

mens have antennæ of seven joints, but otherwise agree with the type, and the antennal difference is not important. The buff-coloured meal covering the dorsum readily distinguishes the species at first sight.

Dactylopius ericicola, sp. nov. Plate XV., figs. 10, 11.

Adult female varying in colour from dark-brown to red; subglobular, with the ventral surface concave at gestation; accompanied, but not covered, by grey or dirty-white cotton, which is frequently aggregated in masses; length of insect about $\frac{1}{20}$in. Antennæ of seven joints, all subequal except the last, which is as long as any two others. Feet moderate; digitules fine hairs. Anal tubercles very minute and inconspicuous; anogenital ring with six hairs. Epidermis very minutely wrinkled, and bearing some circular spinneret-orifices and some conical spines.

Female of the second stage not observed.

Larva brown, rather elongated and slender; length about $\frac{1}{80}$in. Antennæ rather thick, with six joints, subequal except the last, which is longer than any two others. Feet also thick. Mentum dimerous.

Adult male dark reddish-brown; length about $\frac{1}{40}$in. Antennæ of ten joints, all rather thick and subequal. Feet rather long and slender. Abdominal spike very short; setæ very long.

There is usually much black fungus accompanying this insect, and it is also much infested by a minute yellow hymenopterous parasite.

Hab. In Australia, on *Erica autumnalis*. My specimens are from Mr. French.

I am under the impression that *Erica autumnalis* is not a native of Australia, and consequently the insect here described may not be Australian, but perhaps imported there from the Cape of Good Hope. I cannot identify it with any known species, though it comes nearest to *D. globosus*, Mask., from which it differs by not being covered by its cotton, and in the characters of the epidermis.

Dactylopius nipæ, sp. nov. Plate XV., figs. 12–15.

Adult female dark-red in colour, flattish, subcircular; diameter about $\frac{1}{30}$in. exclusive of the cotton; excreting on the dorsum whitish or yellowish cottony meal, and all round the margin subcylindrical tassels of yellowish cotton, which are sometimes equally long all round, sometimes longer posteriorly; the dorsal meal is often arranged in rows in little granular masses. Antennæ of either seven or eight joints, of which the last is much the longest, the third and the penulti-

mate slightly longer than the rest. Feet rather long, of normal form; lower digitules very slightly dilated. Anal tubercles very minute and inconspicuous; anogenital ring with six hairs. Mentum trimerous. Epidermis with many very minute circular spinneret-orifices. Margin bearing some conical spines not set close together; and some more of these spines are scattered on the cephalic region.

Female of the second stage purplish-red, elongated, flattish; length about $\frac{1}{40}$in.; not covered with cotton, but with sparse white meal on the dorsum and a few cottony tassels at the posterior extremity. Antennæ of six joints.

Larva purplish-red, flattish, elliptical; length about $\frac{1}{80}$in. Antennæ of six rather thick joints, the last much the longest, the rest subequal. Anal tubercles very small, convergent, bearing moderate setæ.

Male pupa enclosed in white cotton; usually aggregated in masses on the leaf.

Adult male brownish-red; length about $\frac{1}{40}$in. Wings not iridescent. Antennæ of ten joints, the third, fourth, and tenth longer than the rest. Dorsal eyes two, ventral eyes two, ocelli two. Abdominal spike short and very broad at the base, having the appearance of two basal lobes with a conical process. Feet moderate; at the extremity of the tibia are several strong spines.

Hab. In Demerara, on an aquatic palm, *Nipa fruticans.* My specimens were sent to me by Mr. J. W. Douglas, who has allowed me to describe the insect here.

In outward appearance this resembles rather a *Ripersia*, from the character of the cottony processes of the adult female; but, some specimens showing seven and others eight joints in the antennæ, I attach it to *Dactylopius.* I believe it to be quite distinct.

Dactylopius eucalypti, Maskell. N.Z. Trans., vol. xxiv., p. 35.

The specimens of this insect which Mr. Crawford sent to me a few years ago were clustered between sheets of bark in a mass of cotton, mingled with larvæ and males. I have lately received from Mr. W. W. Froggatt, of Sydney, a large number on leaves of *Eucalyptus robusta.* These specimens agree entirely with my South Australian types as far as regards the anatomical characters of the antennæ, feet, and anogenital ring, and also the feathery fringe of the larva; but instead of secreting cotton they are naked, each resting in a pit or depression in the leaf which exactly corresponds to its outline. As these specimens were sent to me in alcohol I am unable to say whether in nature they would have any cotton or not; but in any case the point is not important in view of the ana-

tomical characters, and probably the modes of growth on the leaves or under the bark may differ to that extent.

On account of this difference it is necessary to be rather more precise than I was in 1891 in detailing the organic characters of this species. The most important of these is the anogenital ring, which departs entirely from the type of *Dactylopius*, having more than six (usually twenty) hairs. This character, as far as experience goes at present, is sufficient to determine the species at once. With regard to the mentum, I was in doubt last year whether it is monomerous or not: further examination leads me to think it is not, and it would therefore not be exceptional; but certainty as to the mentum is by no means easy. The antenna has seven joints, as mentioned in 1891; it may be recognised by two very long hairs, one on the first and the other on the second joint (with, of course, other shorter hairs). The four digitules are all much longer than the claw.

I shall still leave this species in *Dactylopius*, in spite of the exceptional anal ring. Perhaps some day somebody may find out how it constructs the pit on the leaf in which it lives.

Genus Pseudococcus, Westwood.

Pseudococcus nivalis, sp. nov. Plate XVI., figs. 1–4.

Adult female covered with a quantity of white cotton, and excreting also a white cottony ovisac of less dense texture than that on the dorsum. This ovisac is frequently prolonged posteriorly as in the Lecanid genus *Pulvinaria*. Insect yellowish-brown, elliptical, slightly convex; length about $\frac{1}{12}$in. Antennæ of nine joints, the first short, the second the longest, the rest gradually diminishing to the eighth, the last as long as the fourth; the fourth, fifth, and sixth are more slender than the others. Feet rather long and slender; tarsal digitules fine hairs; there are no digitules on the claw. Anal tubercles very minute and inconspicuous, setiferous; the anogenital ring has six hairs. Margin bearing on each segment a group at each side of large circular spinnerets, and these are also numerously scattered on the dorsal abdominal region. On the cephalic region are groups of conical spines.

Female of the second stage, and larva, not observed.

Adult male dark-yellow or orange; length about $\frac{1}{30}$in. Antennæ of ten joints, diminishing gradually from the third to the tenth. Abdominal spike short; there are two very long "tails" and two shorter median setæ. Dorsal eyes two, ventral eyes two, ocelli two.

Hab. In Australia, on *Acacia* sp. My specimens are from Mr. Koebele; the locality either Sydney or Brisbane.

The form of the antenna of the female, nine-jointed, and more slender in the middle than at either end, is characteristic of the genus. The species differs slightly from any hitherto reported.

Pseudococcus casuarinæ, sp. nov. Plate XVI., fig. 5.

Adult female covered with a quantity of white cotton, which has normally a globular form, but is often aggregated in masses; there seems to be no posterior ovisac. Insect yellowish-brown, elliptical, slightly convex; length about $\frac{1}{5}$in., but shrivelling at gestation. Antennæ of nine joints, of which the second is much the longest (as long as any two others), the rest gradually diminishing to the eighth, the ninth as long as the sixth. The fourth, fifth, and sixth are the most slender. Feet rather long and strong; tarsal digitules fine hairs. There is no lower pair on the claw. Anal tubercles very small; anogenital ring with six hairs. Epidermis bearing large numbers of small circular spinnerets and short fine hairs, and on the margin of each segment at each side is a group of orifices mingled with conical spines.

Female of the second stage not observed.

Larva brown, flattish, elliptical; length about $\frac{1}{80}$in. Antennæ of six rather thick joints, the sixth much the longest, the rest subequal. Anal tubercles small, setiferous.

Male unknown.

Hab. In Australia, on *Casuarina* sp. Specimens from Mr. Lidgett, of Myrniong, Victoria.

Genus RIPERSIA, Signoret.

Ripersia leptospermi, Maskell. Trans. Roy. Soc. South Australia, 1887–88, p. 106. Plate XVII., fig. 6.

Female of the second stage dark-red, with white cotton and meal; form flattish, elongated, broadest posteriorly; conspicuously segmented; length about $\frac{1}{40}$in. Antennæ of six joints, of which the third is as long as all the rest together. Feet long; the tibia is longer than the tarsus. Anal tubercles rather small, convergent, setiferous. Margin of body rough with numbers of thick tubular spinnerets with wide bases and slightly tapering, as in the adult, and others similar are scattered on the dorsum.

Male pupa covered with white cotton.

Adult male red; wings grey; length of body about $\frac{1}{40}$in. Antennæ of ten joints, the last four rather thick and short. Dorsal eyes two, ventral eyes two, ocelli two.

Hab. In Australia, on *Leptospermum* sp. The specimens here described were sent by Mr. Koebele from Sydney.

When I described, in 1887, the adult female and the larva of this species, I had not seen the second stage or the male.

Subdivision IDIOCOCCIDÆ, Subd. Nov.

Last year I had to report two genera as to which I was then unable to decide their proper position. One of these, *Sphærococcus*, included only one species; the other, *Cylindrococcus*, had two, and possibly three. Since then I have received specimens of three species which I propose to place in *Sphærococcus*, and I have been able to fix definitely the affinities of the third species of *Cylindrococcus*. Under these circumstances not only can I maintain the genera established last year, but I find it advisable to erect a new subdivision to include both of them, for it is not possible to attach them to any hitherto known. As for their group affinities, I shall leave them amongst the *Coccidinæ*, because they certainly are more nearly related to the members of that group than to the Lecanids; but, even so, their characters are so strange that I have thought it best to indicate the fact by the name of my new subdivision. Moreover, having decided thus much, I propose to characterize the *Idiococcidæ* by such wide and comprehensive features as will permit the future inclusion therein of other genera which may hereafter be discovered: in fact, I mean the subdivision to serve as a receptacle for, perhaps, many insects which cannot possibly enter into the others, and so we may avoid, as far as possible, multiplication of names.

Idiococcidæ.

Adult females active or stationary; gall-making, or naked, or producing cotton or wax. Anal tubercles entirely absent; anal ring hairless. Antennæ with usually less than seven joints. Body not prolonged posteriorly.

The insects belonging to this subdivision are separated from the *Monophlebidæ* by the absence of anal tubercles and by the antennæ; from the *Brachyscelidæ* by the absence of any abdominal prolongation or "tail"; from the *Acanthococcidæ* and the *Dactylopidæ* by the absence of anal tubercles, and the hairless anogenital ring. They come nearest, perhaps, to the subdivision *Coccidæ*, which includes only the single genus *Coccus* (cochineal), and in which the anogenital ring is also hairless. But *Coccus cacti* possesses (though very small and inconspicuous) the usual anal tubercles. Moreover, although I do not lay much stress upon external similarity or dissimilarity, I cannot bring myself to consider *Coccus* as really closely allied to either *Sphærococcus* or *Cylindrococcus*. This question has given me an amount of trouble and study which anybody except a systematic entomologist would probably consider excessive; and it is only after several months of hesitation and frequent changes of

mind that I have decided upon erecting this new subdivision, and placing therein the new species discovered during the past year.

Genus SPHÆROCOCCUS, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 39.

Adult females naked, or producing cotton or wax. Anal tubercles absent; anogenital ring hairless. Antennæ of usually less than seven joints, sometimes atrophied. Feet sometimes absent, sometimes atrophied, sometimes deformed.

Adult male unknown.

Last year I was not prepared to attach any definite characters to this genus. Even now, though I am including three more species in it, I am compelled to leave the characters thus vague and general, in order to avoid erecting a new genus to suit each one.

Sphærococcus acaciæ, sp. nov. Plate XVI., figs. 6–11.

Adult female covered with white cotton, which singly is globular, but may be aggregated in masses. Insect globular, dark-brown; diameter about $\frac{1}{9}$in. Antennæ and feet absent. Anogenital ring very small and difficult to detect, simple, hairless; anal tubercles absent. Epidermis bearing numbers of minute tubular spinnerets; and on the median dorsal region a great many small clear oval markings. Spiracles large.

Female of the second stage not observed.

Larva brown, flattish, elliptical; length about $\frac{1}{65}$in. When observed within the body of the mother it is seen to have antennæ of four moderately long subequal joints, on the last of which are two long hairs; after emergence the joints become shorter and rather confused, but the joints and hairs may still be made out. Feet thick and clumsy, the joints swollen; claw very small; the digitules seem to be all fine hairs. Margin bearing some very slender spines. Anal tubercles absent or atrophied, but there are the usual two terminal setæ.

Male unknown.

Hab. In Australia, on *Acacia* sp. Specimens sent by Mr. A. S. Olliff, from Queanbeyan, New South Wales.

This insect is allied to *S. casuarinæ*, Mask., reported last year, but differs quite sufficiently for specific separation.

Sphærococcus bambusæ, sp. nov. Plate XVI., figs. 12–19.

Adult female producing white cotton, which forms a cushion under it and sometimes partially covers it; this cotton frequently appears quite hard and solid. Insect dark-brown, elongated, slightly convex, usually tapering somewhat posteriorly; the cephalic region is very large, the abdominal

segments short and compressed. Length about $\frac{1}{5}$in. The epidermis is very hard and solid, and resists the action of potash even after prolonged boiling. The antennæ are almost completely atrophied, and are exceedingly difficult to detect, being placed close to the anterior margin, where the skin is darkest and hardest, so that it is only by very careful search that they can be seen at all; they are roundly conical, composed of apparently three or four joints much confused; there are a few terminal hairs. Feet entirely absent. Anal tubercles absent; the anogenital ring is difficult to examine owing to the hardness of the epidermis; it is simple and hairless. The abdominal extremity is truncate. Epidermis bearing great numbers of minute fine hairs dorsally, and on the ventral surface on each segment at each side is a group of small elliptical orifices placed close together.

Female of the second stage brown, slightly convex and elongated; length about $\frac{1}{12}$in.; the cephalic region large and the abdominal segments small, as in the adult; posterior extremity truncate. Antennæ close to the cephalic margin, small, conical, atrophied as in the adult, with three or four confused joints. Feet absent. The anogenital ring seems to have six slender hairs. Epidermis bearing great numbers of circular spinneret-orifices. Margin having a few slender spines, which are more numerous on the abdominal segments.

Larva red, with white cottony meal; elongated, flattish; length about $\frac{1}{40}$in. The form is narrow and looks disproportionately long. Antennæ rather long, with six joints, of which the sixth is much the longest and largest, the third, fourth, and fifth the shortest and subequal. Feet moderately long; the tibia and tarsus are about equal; the digitules are fine hairs. Abdominal extremity slightly truncate; anal tubercles very small or absent; terminal setæ normal; anal ring with six hairs. Margin with a few cephalic slender spines and one on each side of each abdominal segment. Mentum dimerous.

Male unknown.

Hab. In Sandwich Islands, on bamboo. Specimens sent from Honolulu by Mr. Koebele.

This is a very peculiar and striking insect, which I cannot place elsewhere than in this genus. It is one of the most difficult with which I have had to deal, as regards the various organs, on account of the excessive hardness of the epidermis. Yet I believe that the account here given of it is sufficiently correct.

Sphærococcus inflatipes, sp. nov. Plate XVII., figs. 1–5.

Adult female covered by a waxy test, which is open beneath, convex above; the dorsal region of the test is elevated in a more or less conical manner, sometimes smoothly

rounded, sometimes with the sides corrugated as if with radiating buttresses; the marginal region is spread out rather flat, but often wrinkled, and the margin itself is usually slightly thickened. The normal outline of a test is subcircular or elliptical, but sometimes three or four have the margins conjoined and as if forming one mass. At the dorsal apex there is a small orifice. Colour of the test yellowish or reddish-brown; the external diameter averages about $\frac{1}{20}$in. When the test and the insect are removed a small slightly-depressed scar is left in the bark, covered with very thin white meal. Between the test and the dorsum of the insect, and not closely attached to either, there is a small, circular, thin, white, waxy indusium, which covers the central portion of the dorsum. The female insect is reddish-brown, filling the test; diameter about $\frac{1}{30}$in.; the dorsal region is rather darker than the ventral; the body is rather thick, subcircular, and slightly depressed. Antennæ slightly tapering, of six short subequal joints, on the last of which are some longish hairs. At first sight there seem to be only two feet, but on examination it is found that the four anterior ones are much smaller and shorter than the posterior pair, which thus appear abnormally large. The four anterior feet are themselves rather swollen, the joints rather thick and wrinkled; the claws are not large, and I can only make out the tarsal digitules; on the trochanter is a long hair. The posterior feet, though large, have not entirely the swollen appearance of the others, and the joints are less wrinkled, but the claw is atrophied and can only be made out with difficulty; tarsal digitules rather long fine hairs, the lower pair absent. The dorsal region bears a very large number of irregularly-elliptical cells, amongst which are some fine spiny hairs; and round the margin is a ring of subconical rather thick spines, those at the posterior extremity being the longest and largest. The ventral epidermis bears fine spiny hairs interspersed with some small circular orifices. The mentum appears to be dimerous. Anogenital ring rather large, simple, hairless; close to it there seem to be two very short setæ.

Female of second stage and larva not observed.

Male unknown.

Hab. In Australia, on *Eucalyptus* sp. Specimens sent by Mr. French from Myrniong, Victoria. The pieces of bark forwarded are covered with numbers of the little brown tests. I think the normal appearance of the bark would be smooth and light-grey, but the Coccids look like an eruption of pustules on the surface. Mr. French tells me that the insect does much damage to the trees.

I cannot put this insect into any other genus than *Sphærococcus* at present. Only one Coccid is known to me so far

which exhibits anything like the excessive development of the posterior feet*—that is *Opisthoscelis gracilis*, Schrader, one of the Brachyscelid group. But I cannot put *S. inflatipes* among the *Brachyscelidæ*. Moreover, after examination of several specimens of *O. gracilis*, I am by no means quite sure that the very long and slender organs noticeable in that insect are really feet; they are very peculiar and abnormal. However, I cannot discuss that question until my friend Mr. Olliff has published his observations on the *Brachyscelidæ*. Meanwhile, *S. inflatipes* is certainly a strange and abnormal insect.

Genus Cylindrococcus, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 41.

Cylindrococcus amplior, sp. nov. N.Z. Trans., vol. xxiv., 1891, p. 44.

Last year, having only a photograph of some galls on a twig, I could not decide upon their specific position, even if (as I thought probable) they belonged to Coccids at all. Since then Mr. Tepper has been kind enough to send me more specimens, and I have ascertained clearly that they contain *Cylindrococcus*. Examination of the enclosed females shows that they are very closely allied to *C. casuarinæ*, Mask. Indeed, I cannot positively point to any feature of the insect itself by which it may be definitely separated from that species; and it is equally difficult to differentiate the larva. Still, the form of the gall, which is evidently intermediate between that of *C. casuarinæ* and that of *C. spiniferus*, may be sufficient excuse for my venturing to consider the species as distinct. I am confirmed in this view by some remarks of Professor Riley, who, in "Insect Life," vol. iv., p. 377, says, "A hundred larvæ of *Braconidæ*, indistinguishable from one another structurally, will construct a hundred distinctive cocoons, each characteristic of its own species." If the cocoon of a Hymenopter is considered sufficient for specific separation, the gall of a Coccid may have equal importance. But I should not like to extend this proposition very far; exceptionally it may pass, but all through my Coccid studies, from 1876 till now (whatever may be their value), I have laid stress (as regards species) chiefly on the organic characters of the insects themselves, and only secondarily on the nature of their coverings and excretions.

Hab. In Australia, on *Casuarina quadrivalvis*. Specimens from Mr. Tepper.

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* I do not here take notice of *Capulinia sallei*, Sign., as only the larval stage of that species has been described.

Subdivision MONOPHLEBIDÆ.

Hitherto a distinctive character of this subdivision has been a ten- or eleven-jointed antenna in the adult female. One of the insects about to be described shows only seven joints, and yet is certainly adult. It will therefore be necessary to modify the foregoing character, and to say "antennæ of *usually* eleven joints."

Genus CŒLOSTOMA, Maskell.

It has been pointed out to me that the name *Cœlostoma* was appropriated by others before I used it for a Coccid genus in 1879—first, by McLeay, in "Annulosa Javanica," 1825, and again by Brullé in 1835. The number of names required nowadays for genera and species is so great that no little ingenuity is necessary to invent one which nobody has ever used before. Duplication is, of course, to be avoided as much as possible. Still, when one considers that not much confusion is likely to result supposing that the same name were taken, say, for a genus of fishes and for a genus of insects, it would not seem necessary for an entomologist to alter his work in order not to collide with an ichthyologist. Certainly it would not do to cumber entomology with duplicate names; and in a paper of mine in 1884 (Trans. N.Z. Inst., vol. xvii., p. 17) I drew attention to the necessity of removing the name "*Chermes*" or "*Kermes*" from the *Aphididæ*, and confining it to its proper family, the Coccids, and I proposed for the former the name *Kermaphis*. Consequently, if there is any certainty as to the priority, the name of *Cœlostoma* must be given up as regards Coccids.

However, I find, in the first place, that McLeay's name (which I suppose must have been given to some Coleopter) is not *Cœlostoma*, but *Cœlostomus*. So, at least, Mr. T. D. Cockerell informs me in a letter. If this be so I do not feel inclined to abandon a name which is not only quite expressive and apt, but has been undisturbed for thirteen years; the difference of termination is sufficient for clearness, and might easily be paralleled in other instances. As regards Brullé's name, which seems clearly to have been *Cœlostoma*, I find that it was attached to a Coleopterous genus which subsequently was merged in *Cyclonotum* (see the synopsis of genera in Westwood, Introd. to Mod. Class. of Insects, vol. ii.); consequently no further notice need be taken of it. Under these circumstances I venture to think that less confusion will arise for students of Coccids, and even for other entomologists, if my name *Cœlostoma* be still retained.

Cœlostoma immane, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 49.

Mr. A. S. Olliff informs me that he has seen specimens of

this "at least half as big again" as those described by me last year. Those in my own cabinet are sufficiently startling, especially when one compares them with some of the minute, almost invisible, Diaspids. The insects alive in their native locality must be worth seeing; and I should greatly like to investigate them there, and to see the males.

Cœlostoma australe, Maskell. Trans. of Linnæan Soc. of New South Wales, 1890, p. 280.

A characteristic feature of the male of this species is the long brush of white glassy filaments springing from the abdominal extremity. Having received from Mr. Koebele a large number of pupæ, each enclosed in a mass of white cotton, "found on the ground amongst Eucalypts, between leaves, and under pieces of stick, bark, &c.," I have been enabled to watch the process of hatching, and the growth of the caudal "brush." The pupa itself is light-red, elongated and somewhat slender, showing rudimentary wings and feet. On emergence therefrom the adult male is also light-red, the body very soft, and the wings flabby and weak. The colour deepens gradually, and the wings expand and become strong; it appears to be a couple of days before the insect acquires its full deep-red colour of the body and nervures. At first there is no sign of the caudal brush, the filaments of which commence to grow after five or six hours, and take two or three days before they reach their full development. Sometimes, when fully grown, the brush forms quite a wide fan of filaments; at other times the filaments are more parallel. I have kept twenty or more of these males in a glass-covered box for more than a fortnight before they died.

This is not the only Coccid male which exhibits a caudal "brush"—a similar feature exists in *Orthezia urticæ*, Linn., and in *Callipappus westwoodii*, Guérin, both of them European insects. But the females of these differ from *Cœlostoma* in possessing rostra, and *Orthezia* also has only eight joints in the antennæ, and belongs therefore to the *Dactylopidæ*.

Cœlostoma rubiginosum, sp. nov. Plate XVII., figs. 7–11.

Adult female dark reddish-brown in colour, but covered with great numbers of short, slender, semi-waxy filaments of lighter colour, the whole producing an effect like rusty iron. Body elongated, thick, much wrinkled but not distinctly segmented, and the margin shows as a ridge running round the insect. Length variable, specimens seen from $\frac{1}{4}$in. to $\frac{3}{8}$in. Antennæ of eleven joints, subequal and tapering; each joint has some short spiny hairs. Feet rather long; the tibia and tarsus are both much curved; the claw is slender, and the articulation with the tarsus not apparent; digitules absent;

many short spiny hairs on each joint. Rostrum and mentum absent. Anogenital ring simple, hairless; anal tubercles absent, but there are two short caudal setæ. Although the short filaments on the dorsum look like hairs, they are not so, as they dissolve in potash, and the epidermis bears great numbers of irregularly oval cells, each with a central small orifice from which evidently the semi-waxy filaments spring.

Female of the second stage, larva, and male not observed.

Hab. In Australia, on *Banksia integrifolia.* Mr. French sent me specimens first from Melbourne, stating that they were "on dead twigs"; later he sent me two on leaves. Afterwards Mr. Koebele sent me two from Semaphore, South Australia, on the same plant.

This is a peculiar species, which is clearly not far removed from *C. immane*, Mask., the gigantic Coccid from central Australia. It is quite distinct from any others of the genus, and I should be glad to obtain a male. The skin of the antennæ and feet seems to be much less chitinous and hard than usual, and it was only after several attempts that I succeeded in preparing specimens for examination.

Genus MONOPHLEBUS, Leach.

Monophlebus crawfordi, Maskell. Trans. Roy. Soc. South Australia, 1887, p. 108; N.Z. Trans., vol. xxiv., 1891, p. 51. Plate XVII., figs. 12–20.

Mr. Koebele has at different times during his second exploration in Australia sent me specimens which he refers to in his letters as *M. crawfordi.* For some time I also considered them to belong strictly to that species; but on careful examination I have come to the conclusion that they differ somewhat; and, although I am not yet prepared to consider them all as specifically distinct, yet I consider two as varieties, and a third quite separate. In outward appearance there is scarcely anything at all to distinguish them, except that the "long white anal seta" mentioned by Mr. Koebele in 1889, and which I have never seen on the *type* of *M. crawfordi*, is visible on the insect which I name in this paper var. *pilosior.*

The following, therefore, is a synopsis of this species and its varieties as known to me at present:—

Monophlebus crawfordi, type: Female varying in length from $\frac{1}{5}$in. to $\frac{1}{3}$in.; colour yellowish-red, with longitudinal bands of purple; antennæ of nine joints, equal in length except the last, which is rather longer than any of the others; feet moderately spinous; epidermis clothed with short fine hairs interspersed with very large numbers of circular spinneret-orifices; no long anal seta.

Monophlebus crawfordi, var. *levis*: Female varying in length from $\frac{1}{4}$in. to $\frac{1}{2}$in.; colour yellowish-red, with longitudinal bands of purple; antennæ of nine joints, of which the last is rather longer than any of the others; feet only scantily spinous; epidermis bearing only very few short fine hairs, many circular spinneret-orifices, and great numbers of short subconical spinneret-tubes; no long anal seta.

Monophlebus crawfordi, var. *pilosior*: Female varying in length from $\frac{1}{3}$in. to $\frac{2}{3}$in.; colour brick-red, with longitudinal and transverse bands of brown, giving it a trellis-like appearance dorsally; antennæ of nine joints, the last rather longer than any of the others; feet strongly spinous; epidermis very thickly clothed with strong hairs, and having only a few circular spinnerets; a long white seta protrudes from the abdominal extremity.

I do not lay any stress upon the differences of size in these varieties; nor do I think that the variation in colour of the last is sufficient to be specific. Possibly, when the males of var. *levis* and *pilosior* may be discovered they may differ so much from the type as to be quite separate; but they are not as yet known.

Monophlebus fuscus, sp. nov. Plate XVIII., figs. 1–4.

Adult female brown in colour, elongated, active, distinctly segmented; length averaging in the specimens seen about $\frac{1}{8}$in. Antennæ short, rather thick, not conical, of seven joints, of which the third is the longest, the rest subequal. Feet with several hairs, but only moderately spinous; two very short fine digitules. Epidermis bearing many slender hairs, many circular spinneret-orifices, and some short subconical spinneret-tubes.

Larva brown, elongated-oval, flattish, active; length about $\frac{1}{25}$in. Body covered with numbers of rather thick spiny hairs; on the margin is a row of short thick tubular spinnerets, each terminating with a thickened edge (probably twelve on each side), and from these spring very long, radiating, slender, glassy threads, which are exceedingly brittle. Antennæ slender, of five joints, the last forming a large fusiform club; all the joints bear hairs, but none of these are very long. Anal tubercles small, setiferous.

Male unknown.

Hab. In Australia, on *Eucalyptus* sp. My specimens were sent by Mr. Koebele from New South Wales.

I should have hesitated a long time to consider this as a distinct species, on account of the seven-jointed antenna, which suggested an immature condition, had it not been that

one of my specimens produced a great number of larvæ. All my specimens (about a dozen) are small; but *Monophlebus* varies greatly in size. The larva resembles generally that of *M. crawfordi*, but has no very long hair on the antenna. The excessively long hyaline threads springing from the margin are so brittle that they can only be seen in a newly-hatched larva; even the contact of two larvæ meeting each other in their travels causes them to break off.

Westwood (Arc. Ent., i., 22, 3) describes, under the name of *M. illigeri*, a male of this genus said to come from "Van Diemen's Land"; and Signoret remarks that it is the smallest of the genus. I do not know whether this may possibly be *M. fuscus*. I note also a form which Signoret (Essai, p. 400) considers to be a larva of *M. leachii*, Westw., from India, with seven-jointed antennæ, but which may be an adult female.

Monophlebus sp.

I have received from Mr. Cotes, of the Indian Museum, two specimens of females which appear to belong to this genus, but I should like more material for full identification. Each is about $\frac{2}{5}$in. long, and therefore above the average, and the body is thicker than usual. As the specimens were sent in alcohol, I am unable to say whether they excrete cotton or not; but the epidermis is very slightly hairy, with numerous spinnerets, the antennæ have nine joints of which the last is the longest, and the feet are moderately spinous. Possibly they may be identical with *Monophlebus* (*Drosicha*) *contrahens*, Walker; an insect in Ceylon which has not yet been properly described. *M. contrahens* produces a good deal of cotton.

Genus ICERYA, Signoret.

Icerya koebelei, sp. nov. Plate XVIII., figs. 5–11.

Adult female generally of a rather bright red colour, which seems to darken somewhat with age; covered with dots and patches of cottony meal which are often so thick as to hide the body, and make the insect appear to the naked eye quite white. Length of the insect reaching $\frac{1}{10}$in., but no specimen observed exceeded that length. Form generally resembling that of *I. purchasi*, Mask., being elliptical, flattish beneath, the dorsum elevated, and presenting the appearance of an irregularly-raised ridge; body corrugated, but the segments are not clearly distinct. Epidermis bearing numbers of rather long densely-black hairs, irregularly scattered and not arranged in tufts, though they are most numerous on the margin. From the centre of the dorsal region springs a rather thick subcylindrical column of white cotton, forming a pencil which is sometimes nearly as long as the whole body; this column

is more solid than the dorsal cotton, and is quite conspicuous. At gestation the insect forms beneath it an ovisac of usually rather yellow cotton, the abdominal region becoming raised up; this ovisac in all the specimens observed was very short, scarcely extending beyond the abdomen, yet it was clearly complete and mature, for larvæ emerged from it during three weeks that the insects were under observation, and its dimensions did not increase; the cotton exhibits slight longitudinal corrugations. The antennæ are of ten joints, very slightly tapering; the three first and the last are the longest and subequal, the others rather short and subequal. The feet are rather strong and thick, but present no special features. Epidermis bearing numbers of large circular multilocular spinneret-orifices interspersed amongst the long black hairs; but observation of several specimens did not show any tubular spinnerets or glassy tubes. Observation has also failed to show from what special organs or orifices on the dorsum the columnar pencil of cotton is produced. The mentum is trimerous.

Female of the second stage red, rather darker than the adult, covered with patches of yellowish cotton; form elliptical, slightly convex; length about $\frac{1}{18}$in. Antennæ of eight subequal joints, slightly tapering. Epidermis covered with long black hairs and multilocular spinnerets, as in the adult; the marginal hairs form little tufts, one on each side of each segment. At the abdominal extremity are six rather long

Larva red, with dorsal and marginal rows of small tufts of yellow cotton. Length about $\frac{1}{80}$in. Form subelliptical, tapering posteriorly. Antennæ of six joints, subequal except the last, which is a large elongated club, and bears four very long hairs. Abdominal extremity without anal tubercles, but bearing six very long setæ with tubercular bases. Feet long and slender. Dorsal epidermis bearing four longitudinal rows of circular spinnerets, also a row on each margin, and similar rows of fine black hairs.

Male pupa not observed.

Adult male dark-red, the feet and antennæ black. Length of body about $\frac{1}{18}$in., expanse of wings about $\frac{1}{8}$in. Antennæ of ten joints, of which the first two are short and tubercular, the rest long and slender, and each constricted in the middle; on each joint after the second are two rings of long hairs. Eyes prominent, semiglobular, numerously facetted. Abdomen terminating in a short, straight, conical spike, and with two long cylindrical processes, on the ends of which are several long setæ. Wings dark-grey, the nervures red; and there are two longitudinal whitish narrow bands.

Hab. In Australia, on *Leptospermum lævigatum.* Mr.

Koebele, who has sent me several specimens (and to whom I dedicate the species with great pleasure), tells me that he found the insect only on that tree, at Sydney and Brisbane, and not in great numbers.

I believe this to be a distinct species, although evidently closely allied to *I. purchasi*. The difference of size is not of any importance, though the dimensions in every case observed are as given above, and are much less than those of *I. purchasi*. But the dorsal pencil and the ten-jointed antenna, and the very small ovisac of the adult female, are clearly important distinctions. I cannot say that the larva and the male exhibit any special differences except size and the colour of the cotton, but the second-stage female differs in the antenna. None of the other known *Iceryæ* is at all like it, except that some specimens of *I. montserratensis*, Riley and Howard ("Insect Life," vol. iii., p. 99), exhibited ten joints in the female antenna. This character was constant in all the specimens (nine) of *I. koebelei* which I examined. The formation of the dorsal column of cotton is not clear to me; as mentioned above, I have failed to find any special organs, or even any orifice or group of orifices, which might be taken as its source; perhaps somebody else may be more fortunate.

The species of *Icerya* now known to science are as follows:—

I. seychellarum, Westwood, 1855 (= *I. sacchari*, Guérin, 1867); Mauritius, on sugar-cane.

I. purchasi, Maskell, 1878; originally Australia, now many countries, on almost everything.

I. ægyptiaca, Douglas, 1890; Egypt, on *Ficus*.

I. montserratensis, Riley and Howard, 1890; Montserrat, West Indies, on various plants.

I. palmeri, Riley and Howard, 1890; Mexico, on grapevine. Only the larva and second stage observed.

I. rosæ, Riley and Howard, 1890; Key West, Florida, on rose.

I. koebelei, Maskell, 1892; Australia, on *Leptospermum lævigatum*.

There is no reason for thinking that this new species of the genus will be as mischievous as *I. purchasi*, although, indeed, the latter is less troublesome perhaps in its native country than it has been in the others to which it has migrated.

Group BRACHYSCELIDÆ, Schrader.

Genus CARTERIA, Signoret.

Carteria decorella, sp. nov. Plate XVIII., figs. 12–20.

Adult female covered by a waxy test, which, at first single and separate, becomes later on aggregated in masses on the

twig. The normal form of a test is subcircular, rather convex; the colour is yellowish-brown; the diameter would average about $\frac{1}{6}$in. if separated at full growth. The centre of the dorsal portion is occupied by a small elongated narrow red or purple lamina of wax transversely corrugated, and evidently the remains of the test of the early second stage; from this to the margin radiate a number of narrow ridges and depressions which give a corrugated appearance to the whole test; at the posterior extremity of the small central lamina there is a minute orifice. When detached from the twig the underside of the test is seen to be nearly solid, with a small orifice in the middle, so that the insect is almost entirely enclosed. The female insect is dark-red, of the normal globular form of the genus prolonged posteriorly in a short subcylindrical "tail." Antennæ and feet absent. The usual large spine is present just above the abdominal process. The lac-tubes are, as usual, situated on the thoracic region; they are prominent, subcylindrical, and bearing groups of excretory glands. The body of the insect is very inconspicuously segmented, and on each margin of a segment is a group of very small subcircular spinneret-orifices.

Female of the second stage covered by a waxy test which at first is elliptical and very slightly convex, but later becomes subcircular, with a central small elongated and narrow corrugated lamina from which depressions radiate to the margin; these depressions are comparatively more conspicuous than in the adult test, producing a more deeply corrugated appearance. Usually the median region is reddish or orange-coloured, the marginal corrugations whitish or yellowish; but the difference between a late second test and an early adult are not easy to make out. These second-stage tests average about $\frac{1}{25}$in. in diameter in the early stage. The enclosed insect is at first elongated-elliptical, gradually assuming a subglobular form; colour red. I have not been able to satisfy myself as to the antennæ or feet; but probably both are absent.

I have not observed any larvæ after emergence; but in some adult specimens examined there were a great number of embryonic larvæ; these were red, elliptical, tapering posteriorly, the abdomen ending in two divergent and conspicuous anal tubercles, each bearing a long seta and some short hairs. The antennæ and feet were not sufficiently developed for observation.

Male pupa covered by a test of red or yellowish-red wax. The form of the test is elongated-elliptical, convex above, the median region moderately rough and frequently simulating the form of the elliptical segmented enclosed pupa; the margin is corrugated as in the case of the female. Length of the test about $\frac{1}{20}$in. At the posterior extremity there is a flat hinged

plate, on lifting up which the adult escapes. The enclosed pupa is dark-red.

Adult male dark-red, the wings hyaline with red nervures. Length of the body about $\frac{1}{30}$in. exclusive of the spike. Antennæ of ten joints, the first two short and tubercular, the next five long and slender but diminishing somewhat to the seventh, the eighth and ninth shorter and thicker, the tenth as long as the fifth, very thick and subelliptical; all the joints bear several hairs. Feet long and slender, but with no special characters. The abdominal spike is straight and rather long, being nearly as long as the abdomen. The terminal abdominal tubercles bear each two setæ, from which spring moderately long cottony "tails."

Hab. In Australia. Mr. Koebele sent me specimens of the males and the second-stage females on *Myrica cerifera*, from Sydney. Mr. Olliff later on sent me two parcels of the adults at different times on a "native shrub," the bark of which appears to me not to be the same as that of *Myrica*. The first of these two parcels was so much parasitized that I could make nothing of it; and in the second there were so many parasitic larvæ enclosed in the masses of wax that it was with great difficulty I extracted a few uninjured specimens of *Carteria*. These parasites seemed to burrow through the waxy tests and feed at leisure on the imprisoned insects, and the whole space was filled with their excretions.

This, in the form of the tests, especially those of the male and the second-stage female, is a very pretty species. It may be very easily mistaken at first sight for a *Ceroplastes*, from the corrugations of the tests; indeed, Mr. Koebele originally sent it to me under that name. As usual with *Carteria*, a great deal of care is necessary to ascertain the real shape of the body, and the epidermis is so tender that the ordinary processes for diagnosis must be undertaken with much caution. The pupal tests both of male and female form pretty microscopic objects.

Carteria melaleucæ, Maskell. N.Z. Trans., 1891, vol. xxiv., p. 54.

The waxy tests of several specimens of this species which I have received from Mr. Koebele and Mr. Olliff during the past year have presented a number of small knobs and excrescences which were not noticeable on those sent me in 1891 by Mr. French. These later specimens were on *Leptospermum*, Sydney, and, as the enclosed insects were identical with *C. melaleucæ*, I would not attempt to separate them simply on account of the small differences in the tests.

The second-stage female resembles nearly that of *C. acaciæ*, Mask., 1891, but the test is much darker in colour.

INDEX TO PLATES XI.-XVIII.

Plate XI.

Fig. 1. *Aspidiotus eucalypti*, female, showing groove.
Fig. 2. " " markings of epidermis.
Fig. 3. " *theæ*, lattice-work of pygidium.
Fig. 4. *Diaspis* (?) *fimbriata*, insects on leaf.
Fig. 5. " adult female.
Fig. 6. " pygidium of female.
Fig. 7. *Mytilaspis casuarinæ*, insects on twig.
Fig. 8. *Leucaspis cordylinidis*, insects on leaf.
Fig. 9. " pygidium of female.
Fig. 10. *Chionaspis brasiliensis*, insects on leaf.
Fig. 11. " puparia, male and female.
Fig. 12. " pygidium of female.
Fig. 13. " foot of male.
Fig. 14. *Fiorinia syncarpiæ*, insects on leaf.
Fig. 15. " pygidium of female.

Plate XII.

Fig. 1. *Inglisia foraminifer*, insects on twig.
Fig. 2. " test of female.
Fig. 3. " test of male.
Fig. 4. " antenna of female.
Fig. 5. " foot of female.
Fig. 6. *Ceroplastes rubens*, insects on leaf.
Fig. 7. " " test of female.
Fig. 8. " " test of larva.
Fig. 9. " " antenna of female.
Fig. 10. " " foot of female.
Fig. 11. " *ceriferus*, insects on twig in wax.
Fig. 12. " " test of female, second stage.
Fig. 13. " " adult female, side view.
Fig. 14. " " antenna of female.
Fig. 15. " " "tail," after treatment with potash.
Fig. 16. " " spiracular spines.

Plate XIII.

Fig. 1. *Lecanium tessellatum*, markings of epidermis.
Fig. 2. " *acuminatum*, adult female.
Fig. 3. " " markings of epidermis.
Fig. 4. " *filicum*, insects on frond of fern.
Fig. 5. " *scrobiculatum*, adult female.
Fig. 6. " " spiracular spines.
Fig. 7. " " antenna of female.
Fig. 8. *Pulvinaria dodonææ*, insects on twig.
Fig. 9. " " adult female and ovisac.
Fig. 10. " *psidii*, insects on leaf.
Fig. 11. " " antenna of female.
Fig. 12. *Signoretia luzulæ*, insects in sacs on grass.
Fig. 13. " foot of female.

Plate XIV.

Fig. 1. *Prosopophora acaciæ*, insects on twig.
Fig. 2. " test of female.
Fig. 3. " test of male.
Fig. 4. " adult female.
Fig. 5. " antenna of female.
Fig. 6. " foot of female.

Fig. 7. *Prosopophora acaciæ*, spinnerets of female.
Fig. 8. „ *eucalypti*, insects on twig.
Fig. 9. „ „ test of female.
Fig. 10. „ „ test of male.
Fig. 11. „ „ antenna of female.
Fig. 12. *Gossyparia casuarinæ*, insects on twig.
Fig. 13. „ „ adult female.
Fig. 14. „ *confluens*, insects on twig.
Fig. 15. *Eriococcus turgipes*, insects on twig.
Fig. 16. „ adult female, ventral view.
Fig. 17. „ antenna of female.
Fig. 18. „ foot of female, viewed from below.
Fig. 19. „ foot of female, side view.
Fig. 20. „ anogenital ring.

PLATE XV.

Fig. 1. *Eriococcus coriaceus*, insects on twig.
Fig. 2. „ „ adult female.
Fig. 3. „ „ antenna of female.
Fig. 4. „ *conspersus*, insects on twig.
Fig. 5. „ „ antenna of female.
Fig. 6. „ „ markings of epidermis.
Fig. 7. *Rhizococcus casuarinæ*, larva, dorsal view.
Fig. 8. „ *pustulatus*, antenna of female.
Fig. 9. „ „ markings of epidermis.
Fig. 10. *Dactylopius ericicola*, insects on twig.
Fig. 11. „ „ adult female.
Fig. 12. „ *nipæ*, insects on leaf.
Fig. 13. „ „ adult female.
Fig. 14. „ „ antenna of female.
Fig. 15. „ „ antenna of male.

PLATE XVI.

Fig. 1. *Pseudococcus nivalis*, insects on leaf.
Fig. 2. „ „ insects on leaf, enlarged.
Fig. 3. „ „ antenna of female.
Fig. 4. „ „ foot of female.
Fig. 5. „ *casuarinæ*, antenna of female.
Fig. 6. *Sphærococcus acaciæ*, insects on twig.
Fig. 7. „ „ adult female.
Fig. 8. „ markings of epidermis.
Fig. 9. „ larva, ventral view.
Fig. 10. „ antenna of larva.
Fig. 11. „ foot of larva.
Fig. 12. *bambusæ*, insects on bamboo.
Fig. 13. „ adult female.
Fig. 14. „ antenna and epidermis of female.
Fig. 15. „ abdominal extremity of female.
Fig. 16. „ group of oval glands.
Fig. 17. „ female of second stage.
Fig. 18. „ larva.
Fig. 19. „ antenna of larva.

PLATE XVII.

Fig. 1. *Sphærococcus inflatipes*, insects on bark.
Fig. 2. „ tests of female.
Fig. 3. „ adult female, dorsal view.
Fig. 4. „ antenna of female.
Fig. 5. „ markings and hairs of epidermis.

Fig. 6. *Ripersia leptospermi*, female of second stage.
Fig. 7. *Cœlostoma rubiginosum*, insects on twig.
Fig. 8. „ antenna of female.
Fig. 9. „ foot of female.
Fig. 10. „ epidermis, showing waxy processes.
Fig. 11. „ epidermis after treatment with potash.
Fig. 12. *Monophlebus crawfordi*, type, adult female.
Fig. 13. „ type, epidermis.
Fig. 14. „ type, foot.
Fig. 15. „ var. *levis*, adult female.
Fig. 16. „ „ epidermis.
Fig. 17. „ „ foot.
Fig. 18. „ var. *pilosior*, adult female.
Fig. 19. „ „ epidermis.
Fig. 20. „ „ foot.

PLATE XVIII.

Fig. 1. *Monophlebus fuscus*, adult female.
Fig. 2. „ antenna of female.
Fig. 3. „ foot of female.
Fig. 4. „ larva, dorsal view.
Fig. 5. *Icerya koebelei*, insects on twig.
Fig. 6. „ female, enlarged.
Fig. 7. „ apex of dorsum, side view.
Fig. 8. „ antenna of female.
Fig. 9. „ foot of female.
Fig. 10. „ antenna of larva.
Fig. 11. „ abdominal extremity of larva.
Fig. 12. *Carteria decorella*, adult females in tests on twig.
Fig. 13. „ tests of second-stage females and males on twig.
Fig. 14. „ tests of adult females.
Fig. 15. „ tests of second-stage females.
Fig. 16. „ test of male.
Fig. 17. „ adult female, dorsal view.
Fig. 18. „ lac-tube of female.
Fig. 19. „ adult male.
Fig. 20. „ antenna of male.

ART. XXVII.—*On the Geographical Distribution of* Atax.

By Dr. H. v. JHERING, Rio Grande do Sul, Brazil.

Communicated by G. M. Thomson, F.L.S.

[*Read before the Otago Institute, 12th July, 1892.*]

ENGAGED as I have been upon the study of the *Unionidæ*, I have endeavoured to obtain Australian and New Zealand species, and in particular to secure examples containing the animals. Up to the present time I have only been able (thanks to the kindness of Professor Hutton) to obtain specimens of one species—*Unio menziesii*, Gray—containing the

animal, and this I find to be somewhat similar to some forms of *Unio* from the Brazils. The branchiæ are fastened throughout their whole length to the mantle and to the abdomen, and it is in the internal branchiæ that the eggs and the embryos are contained. Among nine specimens examined by me I have not found any parasites. What is wanted is that observations should be directed to other species, and also that collections of young individuals should be made with apices intact. Nothing is as yet known of the configuration of the beaks (umbones) of the shells of the New Zealand and Australian *Unios*, nothing at all (as far as I know) of their anatomy and embryology, and nothing about their parasites.

In my studies on the *Unionidæ* of the Brazils I was struck by the fact that certain parasites on them are somewhat nearly related to European species, while others known to occur in Europe are wanting. For example, I have never met with *Aspidogaster* in the pericardium, but I have come across several sporocysts, or rediæ, in examining the cercaria, especially those of *Bucephalus*, scarcely different from European species.

I do not know whether any one has also noticed this in New Zealand or in Australia. I have frequently also observed species of *Atax*, a genus of (parasitic) Hydrachnids commonly found in the *Unios* and *Anodontas* of Europe. The three or four species which I have observed were studied and described by Dr. Koenike, of Bremen, as they were all new. Dr. Koenike has verified the fact recorded by Leidy, that in the *Unios* of the United States there exists, among other species, one—*Atax ypsilophorus*—identical with a form found in Europe. With regard to the other species, it will be necessary to continue observations in order to learn which are common to the two regions and which are peculiar to each.

I was therefore curious to see if *Atax* also occurred in *Unio menziesii;* but hitherto I have not met with it. I am not acquainted with the literature and the geographical distribution of the Hydrachnids, especially with regard to those of Australia and New Zealand, and the object of this note is to draw attention to the subject as one which merits attention and study. A complete knowledge of the distribution of animals will enable us in time to reconstruct the ancient geography of the globe in the different geological epochs, so that the presence or absence of certain genera in the different countries or islands [will] enable us to form definite conclusions on the time of appearance of the genus. On this ground the geographical distribution of parasites gives us a method of arriving at their geological age which palæontology does not furnish us with.

Art. XXVIII.—*Note on some Sea-trout (Salmon or Salmon-trout?).*

By F. Sandager.

Communicated by G. M. Thomson, F.L.S.

[*Read before the Otago Institute, 12th July, 1892.*]

For the last three years I have observed that a species of the *Salmonidæ* visits the bay on the west side of Kartigi Point in considerable numbers. The fish begin to appear in November, but by the end of May most have disappeared. The rocks for some distance out are edged with seaweed, so that I have been unable to fish from the shore, and when trying to do so from the punt the fish invariably disappeared; but I have seen them sufficiently close, when at high-water they occasionally come close to the shore near a small shingly beach, to be certain that the fish belong to the salmon family. The fish seldom or never come in amongst the seaweed, but swim along its outer margin, where small fry of various fish are abundant. During the summer months dozens may be seen from the Lighthouse Reserve, swimming leisurely along, or jumping after thistle-down as it is carried over the surface of the water by a gentle breeze. The fish vary in length from about 1ft. up to close on 3ft., and the smaller fish appear the more active. During May, 1892, an immense number of *Clupea sprattus*, var. *antipodum*, were driven into Kartigi Bay, and on that date the bay along the reserve appeared quite alive with jumping *Salmonidæ;* but whether they were themselves pursued, or after the sprats, I cannot say. Usually the *Salmonidæ* do not depart far from the angle formed by Kartigi Point and the Lighthouse Reserve, where the water is nearly always smooth and small fry plentiful. The depth along the seaweed margin is between two and three fathoms, and the bottom is sandy.

ART. XXIX.—*Notes on a Land Planarian (sent by F. V. Knapp, Hampden State School, Nelson).*

By Sir J. HECTOR, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 13th July, 1892.*]

THIS worm is of some interest, as it is a land Planarian, and probably a new genus and species. Three species of marine Planarians have been described from New Zealand, but only one land form—*Geoplana traversii*—which was described by Mr. Moseley, of the "Challenger" Expedition, from two specimens collected by Mr. Travers, found by him near Wellington. The largest of these only measured 1in. in length, and from other characters was probably very different from the specimen now exhibited. Two genera are known in Australia — *Geoplana* and *Rhynchodemus* — and thirty-five species have been described of the former in Victoria, and only one of the latter. Last year Professor Spencer, of Melbourne, described eight species from Lord Howe's Island. Two belong to a new genus (*Cotyloplana*) and six to *Rhynchodemus*. The discovery of a New Zealand form is therefore important, so as to determine if it is more allied to the Lord Howe's Island form than to the Victorian. The specimen is, however, very distinct, I should think, even generically, from any that I can find described.

It is worthy of note that Professor Baldwin Spencer believes that the genus *Geoplana* is not represented in Lord Howe's Island, whereas Professor Moseley has referred our only hitherto known land Planarian to that genus. This would rather associate our zoological area with south-east Australia, whereas it is well known that in its fauna and flora Lord Howe's Island is far more related to New Zealand than to any part of Australia.

ART. XXX.—*Notes on the Southern Seals.*

By Sir J. HECTOR, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 14th September, 1892.*]

THE following notes having been prepared in reply to an application from the Minister of Marine, it has been thought advisable to place them on record:—

At least nine species of seals frequent the South Island, but the nomenclature has been greatly confused and rendered

untrustworthy by the injudicious record of species founded on imperfect specimens, on characters due only to age and sex, and to reliance having been placed on hearsay evidence. For commercial purposes the following classification may be considered sufficient.

I. Eared Seals (the Otarias).

These, like land mammalia, have a direct communication through the integument from the organs of hearing, and have also an external ear-lobe, which enables them to appreciate the direction from which they receive sounds.

These are again divided into—

A. Hair-seals, or Sea-lions, which are covered with long coarse hair and have no under-fur, and are therefore only commercially valuable for the production of oil, and formerly as food and clothing.

B. Fur-seals, or Sea-bears, which have an under-fur as well as a clothing of long hair, both of which are cast and renewed each summer, so that the skin of the animal when taken at the proper season is of value as a "pelt" or furrier's material. As food they are so inferior as not even to have been used by the aborigines.

II. Earless Seals (the Phocas).

The common varieties of the North Atlantic, such as the Greenland seal, the harbour seal, crested seal, &c., belong to this group, but they are not represented in the southern seas.

This group is known by the following Antarctic representatives:—

A. Sea-leopards, which are large spotted seals covered with coarse hair; but, not being gregarious in their habits, although abundant and widely distributed, having no commercial value.

B. Sea-elephants. These are massive, unwieldy, and gigantic animals, which have a very restricted distribution, being confined to the islands in the extreme south. They are chiefly prized for the large quantity and fine quality of oil which they produce.

III. Walruses (the Sea-pigs).

These are valuable for their oil, and for their ivory, which, though inferior to elephant ivory, is used for the same purposes. The evidence of the actual existence of a southern walrus is at present founded only on hearsay report, but it is very probable that when the great Antarctic islands and ice-floes, as yet unvisited, are explored, not only this but other novel forms will be found.

The walrus, or morse, is now found only in the Polar seas, about and northward of Behring Strait; but their range has been restricted of late, as Captain Cook found them much further south along the coast-line of the North Pacific.

To describe more in detail:—

I. Eared Seals.

A. HAIR-SEALS.

This group, the sea-lions, rendered so familiar by the rookery outside the Golden Gate of San Francisco, is represented in the south by *Zalophus lobatus*, which is found chiefly in the longitude of the Cape of Good Hope, and by *Protoarctus hookeri*, which is supposed to be a different species frequenting the islands in the longitude of New Zealand and southward, and is best known at the present time as the Auckland Islands sea-lion.

Like all the eared seals, these species are polygamous, and have a very definite life-history. The males are enormously larger than the females. About December they take up stations on the coast in warmer latitudes, such as the west coast of New Zealand, and formerly used also to frequent the islands in Bass Strait and on the west coast of Tasmania. Soon afterwards the cow-seals appear, and, on landing, give birth to the young, each male securing a harem of ten to twenty cows, and protecting the mothers and young pups. The rutting-season is in January, after which the males (or lions) leave the mothers to bring up the young until May, when they all leave the coast for the winter. The mode of life of the hair-seals has, however, been much altered since 1863, when I made my first observations, and I believe that the New Zealand hair-seals have now become much more solitary, and that they will soon become extinct.

B. FUR-SEALS, OR SEA-BEARS.

This is in the southern seas "the seal" of commerce, and it is much to be regretted that so little accurate information was collected in former years about its life-history. Three species are supposed to exist (after weeding out many synonyms), but I am inclined to think these even are all the same—*Arctocephalus falklandicus* (of Cape Horn longitude), *A. antarctica* (of the Cape of Good Hope longitude), *A. forsteri* (of New Zealand longitude).

I can only speak of the latter, or New Zealand fur-seal. Formerly they were very abundant along the west coast of the South Island and on the Tasmanian coast. I spent from June, 1863, to January, 1864, in the western sounds of Otago, and have since made many occasional visits at other

seasons, but chiefly during the summer months, from February to May. I have always observed the seals closely, and have collected many specimens.

The male fur-seal used to arrive about the 5th November on inaccessible rocky platforms outside the entrance to the fjords, or sounds, and the cows began to arrive about the 1st December. At the same date all the young stock—males up to seven and females up to three or four years old—went to still more exposed places by themselves, and spent the moulting-season, until about the end of March, when, having acquired the new fur coat, they proceeded to sea. The last of these "hauling-grounds," as they are called, I have known in New Zealand was at Cape Foulwind, but formerly they were all round the coast. In the breeding-grounds or "rookeries" the old males keep guard on the females and newly-born pups until the close of the rutting-season, about the 15th February, and then desert them, being then in a feeble and emaciated condition from having fasted, and fed only on their own fat, for several months. The females remain with the pups until they learn to swim and to catch fish for themselves, and about the end of May they all leave the coast, only occasionally a groggy old bull remaining behind for the winter months.

II. Earless Seals.

A. Sea-leopards.

Of these, four species are known. *Stenorhynchus leptonyx:* This is common round the New Zealand coast, but is a solitary animal. They frequently come on shore, and, notwithstanding their feeble powers of locomotion, they scramble far back into the bush in flat country, and occasionally ascend rivers for a long distance. For instance, one of the seals ascended the Waikato River, a few years ago, as far as Hamilton, and was claimed by the Maoris as being a real "taniwha." Another species, *Leptonychotes weddelli*, was only known until lately from a single specimen obtained by Ross's Antarctic expedition; but last month I identified a splendid specimen in Mr. Drew's museum at Wanganui as being of this species. It was stranded on the beach outside Wanganui Heads. The other two species of earless seals are *Lobodon carcinophaga* and *Omatophoca rossii;* they were both collected in the Antarctic seas, but are only imperfectly known.

B. Sea-elephant (*Macrorhinus elephantina*).

This huge seal was formerly abundant on many of the Antarctic islands, but is now almost confined to Kerguelen's Land, Hood Island, and the Macquarie Islands. It is remark-

able from having the power when enraged of inflating its nose so as to form a proboscis. The male is much larger than the female, being sometimes 22ft. in length, while the female measures about 10ft. They never go far from land, and in the month of November they go ashore in large herds for the purpose of shedding their winter coats, after which the calving takes place. The mating-season is in February, by which time the males become very thin, as they eat no food during their sojourn on land.

This seal was greatly prized for its oil, which is obtained from a thick layer of blubber underneath the skin. They formerly assembled in incredible numbers on the various southern islands, and their bones are found in old Maori camping-grounds on the New Zealand coast. They were first hunted about the commencement of the present century, but it is now many years since they were ruthlessly extirpated on all but a few of the most desolate and inaccessible of their retreats.

A very interesting note regarding the sea-elephant has been given by Professor Scott in his account of the Macquarie Islands (Trans. N.Z. Inst., vol. xv., p. 492).

In conclusion, I may remark that the information which we possess concerning the life-history of the forms which exist in the Antarctic seas is most imperfect and unsatisfactory, especially with regard to the forms that are commercially valuable, such as seals, whales, and fishes.

Professor Sir W. Turner, of Edinburgh University, gives the following classification in vol. xxvi. of the "Reports of the 'Challenger' Expedition":—

A. EARLESS SEALS.

PHOCIDÆ.

Phocinæ.

Arctic.
Phoca vitulina. North Atlantic.
" *groenlandica* (harp seal). North Atlantic.
" *hispida* (ringed seal). North Atlantic.
" *barbata* (bearded seal). North Atlantic.
Halichærus grypus (grey seal). North Atlantic.

Ogmorhininæ.

Antarctic.
Ogmorhinus leptonyx (sea-leopard).
" *carcinophagus* (crab-seal).
Leptonychotes weddelli.
Omatophoca rossii.

Northern.
Monachus monachus (monk-seal). Mediterranean.

Cystophorinæ.

Northern.
Cystophora cristata (crested seal).

Antarctic.
Macrorhinus leoninus (elephant-seal).

Trichechidæ.

Arctic.
Trichechus rosmarus (walrus).

B. EARED SEALS.

OTARIIDÆ.

S. *Otaria jubata* (S. sea-lion). South America.
N. *Eumetopias stetteri* (N. sea-lion). North Pacific.
N. „ *californianus* (Californian sea-lion).
S. „ *hookeri* (Auckland Islands hair-seal; tiger-seal).
S. „ *cinereus* (grey hair-seal). New Zealand and Australia.
S. *Arctocephalus australis* (South American fur-seal).
S. „ *gazella* (Kerguelen's Land fur-seal).
S. „ *pusillus* (Cape of Good Hope fur-seal).
N. „ *ursinus* (northern fur-seal).
S. „ *forsteri* (New Zealand and Australian fur-seal).
S. „ *philippii* (Juan Fernandez fur-seal).

II.—BOTANY.

Art. XXXI.—*On Heterostyled Trimorphic Flowers in the New Zealand Fuchsias, with Notes on the Distinctive Characters of the Species.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 18th January, 1893.*]

Plate XIX.

Exactly a century ago it was observed by Sprengel that the European water-violet (*Hottonia palustris*, Linn.) produced flowers of different forms on different plants; in one form the pistil was more than twice the length of the pistil of the other. Although convinced that the phenomenon was not accidental, he was unable to discover any reason for its occurrence, and nearly seventy years elapsed before light was thrown on the subject. It is now well known to be a contrivance to insure fertilisation by means of pollen obtained from flowers of another plant, and it has been proved by experiment that the number of perfect seeds in each capsule thus fertilised is much greater than when pollen is applied from the same plant, or from the same form of flower. Pollen from the anthers of either form of flower must be applied to the stigma of the other in order to obtain the most advantageous results.

Flowers of this kind are said to be "heterostyled": but, inasmuch as the difference in the length of the style is often correlated with differences in the length of the stamens, the size of the pollen-grains, and the size of the flower, &c., the late Professor Asa Gray suggested that the term was not sufficiently expressive, and proposed to substitute "heterogone" or "heterogonous"; but, notwithstanding the greater comprehensiveness of the latter term, it has not been generally adopted.

Mere difference in the length of the style or stamens, or both, is not of itself sufficient to render a plant heterostyled; there must be a reciprocal relationship between the pollen of one form of flower and the stigma of the other: this may or may not be accompanied by a difference in the pollen and

sometimes in the stigma. On the other hand, heterostyled flowers may not exhibit any great difference in the length of either style or stamens.

Hottonia palustris exhibits only two forms of flowers, and therefore belongs to the group of heterostyled dimorphic plants. In *Lythrum*, *Oxalis*, and one or two other genera heterostyled trimorphic flowers are developed: in each form there are two sets of stamens, and the style varies in length reciprocally with the stamens, the long-styled form having the shortest stamens, and the short-styled form the longest stamens; one set of stamens in each form is of the same length as a set in one of the other forms. No pistil can be fully fertilised except by pollen from stamens corresponding to the length of its style, but the pistil of either form may be fertilised by pollen from one or both the other forms.

The arrangements for cross-fertilisation in the New Zealand species of *Fuchsia* are much less complicated than in *Lythrum* or *Oxalis*, and combine with heterostyled trimorphism a marked tendency to unisexuality, the long-styled form in each species being practically a female flower, although in some instances capable of self-fertilisation.*

The variation in the form of the flowers of the New Zealand fuchsias has been long recognised, although even yet it can scarcely be said to be fully understood. Sir Joseph Hooker, under the description of *Fuchsia excorticata*, in the "Flora Nov.-Zel.," volume i., page 56 (1853), remarks, "The stamens vary much in length, being sometimes quite included"; and was so much impressed by the short-styled form of *F. procumbens* that he was led to consider it a distinct species, and described it as such under the name of *F. kirkii*. After pointing out that it was impossible to distinguish the two plants by the leaves alone, he adds, "In the flowers they differ widely. . . . At first I was inclined to think that these differences might be sexual; but I should rather regard them as diagnostic of two representative species that possibly had a comparatively recent origin." † Mr. G. M. Thomson detected two forms of flowers, one of which he rightly stated to be hermaphrodite in structure but pistillate in function.‡ Unfortunately, with other southern botanists, he failed to distinguish between *F. colensoi* and *F. procumbens*, and consequently has no distinct reference to the heterostyled flowers of the latter.

All the New Zealand species agree in having alternate leaves and axillary solitary flowers, although in *F. excorti-*

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* If it were not for the two forms of hermaphrodite flowers, the New Zealand fuchsias might be termed gynodiœcious.

† Ic. Pl., 3rd ser., i., 67.

‡ Trans. N.Z. Inst., vol. xiii. (1880), p. 264.

cata the flowers are sometimes aggregated on very short branchlets, with undeveloped internodes. They further agree in having deep-blue dry pollen, bound together with extremely delicate threads, which are slightly viscid,* and penetrate the mass in all directions, so that the pollen-grains readily adhere to the feathers of birds which frequent the trees for the sake of the honey afforded by the flowers.†

It will now be convenient to describe the general structure of the different forms of flowers produced by each species.

Fuchsia excorticata, L. fil.

In this species the flowers are pendulous, and at first of a deep-purple colour blotched with green; ultimately they assume a dull-red tint. Immediately above the ovary the calyx-tube is dilated in a globular form, then suddenly constricted, when it becomes funnel-shaped; the limb is divided into four acute spreading lobes; the tube is marked externally by eight more or less elevated ridges, caused by the insertion of the filaments; the deep violet-coloured petals are very small, and alternate with the segments of the calyx. The introrse anthers are carried on rigid but very delicate filaments, which vary in length even in the same flower, and are attached to the anthers in an obliquely-peltate manner. The stigma is globose, minutely papillose, and obscurely four-lobed on the upper surface.

Three principal forms of flower may be observed, but each plant produces a single form only. The different forms may be described as under:—

1. *The Long-styled Form.*—In this form the flower is slightly smaller than either the mid- or short-styled forms. The style is fully twice the length of the calyx-tube, but the filaments are so extremely short that at first sight the anthers appear to be sessile, and in some instances are partially included in the calyx-tube. The pollen-grains when present are yellow, and almost invariably abortive. The petals are very small, and often contorted.

2. *The Mid-styled Form.*—The style is much shorter than in the previous form, being about one and a half times the

* This character is exhibited by several South American species—probably by all.

† The chief agents in effecting fertilisation in *F. excorticata* are the tui (*Prosthemadera novæ-zealandiæ*), the bell-bird (*Anthornis melanura*), and, in the extreme north, the stitch-bird (*Pogonornis cincta*). I suspect that the parrakeets *Platycercus novæ-zealandiæ* and *P. auriceps* assist in the process; the white-eye (*Zosterops lateralis*), and in some cases the naturalised sparrow, although not honey-feeders, certainly render assistance, as the blue pollen-grains are frequently found on their feathers: they doubtless frequent the tree in search of insects, while the tui, the bell-bird, and the stitch-bird are attracted by the honey.

length of the calyx-tube; the anthers are carried on long filaments, which are shorter than the style and of nearly equal length, although showing a slight tendency to form two sets. The pollen is of a deep mazarine-blue and well developed, the grains differing but slightly from those of the short-styled form. Petals larger than in the long-styled form, never contorted.

3. *The Short-styled Form.*—In this form the style is shorter than in either of the preceding, while the stamens are longer and of unequal length, the longer alternating with the shorter and nearly equalling the style, or in some cases exceeding it. Petals rather smaller than those of the mid-styled form, but never contorted.

Fuchsia colensoi, Hook. f.

1. *The Long-styled Form.*—This closely resembles the long-styled form of *F. excorticata,* but the filaments are rather longer; the pollen is usually abortive. Petals minute.

2. *The Mid-styled Form.*—This also corresponds to the mid-styled form of *F. excorticata,* but the filaments are of equal length and more slender. The pollen is of a deep-blue colour. Petals minute.

I have not seen the short-styled form of this species, but entertain no doubt of its existence. As a rule this species does not produce flowers so freely as *F. excorticata,* and my opportunities of examining it during the flowering-season have been comparatively few.

Fuchsia procumbens, R. Cunn.

The flowers of this species are invariably erect and apetalous; the calyx-tube is neither inflated at the base nor marked by raised longitudinal ridges, while the segments are always refracted and never spreading. The stamens are exserted and of uniform length.

1. *The Long-styled Form.*—In this form the style greatly exceeds the stamens, and the stigma is distinctly four-lobed; the anthers are small, and the pollen, although of the same deep-blue colour as the perfect pollen in the preceding species, is probably abortive, but the material at my command is not sufficient to allow this point to be determined. Flowers smaller than in the mid- or short-styled forms. I have not seen this form in a growing condition.

2. *The Mid-styled Form.*—In this form the style exactly equals the stamens, but the flower differs from the preceding in no other particular, except its larger size.

3. *The Short-styled Form.*—The style of this form is shorter than the calyx-tube, in which it is wholly included. Pollen bright-blue.

In *F. excorticata* the three forms grow intermixed, usually in about the same proportion; although the flowers of each tree are uniform, there is a considerable amount of variation in the flowers on different trees, so that it would not be difficult to find intermediate forms, as in *Lythrum græfferi* and *L. salicaria*.

The long-styled form of *F. excorticata* is practically a female flower, as the anthers are almost invariably abortive, and it is especially worthy of note that it produces a larger quantity of fruit than either the mid- or short-styled forms. As the three forms are usually found together wherever the plant is plentiful, it may fairly be assumed that this profusion of fruit is largely due to the application of pollen from both the mid- and short-styled forms; but this point can only be determined by an exhaustive series of experiments. The assumption receives a certain amount of support from the fact that, in a few observed cases where the mid-styled form appeared to be absent, the quantity of fruit produced by the long-styled form was greatly reduced. The same result has been observed in the absence of the short-styled form, and it may well be that the paucity or entire absence of fruit on many trees, even after flowers have been produced in profusion, is at least partially due to the absence of one form or the other.

So far as known to me, *F. colensoi* produces fruit but sparingly, especially in the North Island. May not this be partially due to the absence or comparative rarity of the short-styled form?

No instance is known, so far as I am aware, of the different forms of *F. procumbens* growing intermixed. I have never seen or heard of more than a single form occurring in any one locality. This may well account for the fact that the handsome fruit of this species has not been seen in the wild state. At Tryphena Bay Professor Hutton and myself examined hundreds of flowers, but saw no trace of fruit; subsequently I had the same experience at Mine Bay, and again at Whangaruru. Its original discoverer saw no trace of fruit at Matauri, where he collected the plant during the autumn months, when fruit should have been plentiful.

Although the mid- and short-styled forms are often cultivated, I have never seen both forms in the same garden. At present the long-styled form has not found its way into cultivation in the colony, although it appears to have been cultivated in England for fifty years, and the short-styled form for twenty years. Cultivated plants of the mid- and short-styled forms grown separately, although most frequently sterile, produce fruits occasionally; sometimes only a single berry becomes mature, rarely more than two or three. On one

occasion I saw a specimen in a greenhouse bearing nearly a dozen berries, but this was a solitary instance. The seeds are numerous, but possess a low power of germination. Of the total number of seeds contained in two large fruits from a short-styled plant only two germinated; both came true to the parent, and produced short-styled flowers. The rarity of fruit on cultivated plants and its absence on wild plants is surprising when it is remembered that the flowers are erect, and that the anthers and stigma of the mid- and short-styled forms are in such a position that the transfer of pollen by minute insects could scarcely be avoided; moreover, there is no evident tendency to dichogamy.

F. procumbens is an extremely rare and local plant; it is far from abundant in any of the few localities in which it is found. From the absence of fruit in the wild state, in which only a single form of flower is present, and its rare occurrence in cultivation under the same condition, it must be inferred that each form of flower is sterile with its own pollen, or, at least, that it is not capable of fertilisation in any appreciable degree. The same cause doubtless accounts both for the rarity of the plant and its restricted distribution, as well as for its remarkable uniformity in habit and foliage when compared with *F. colensoi* and *F. excorticata.*

The following conclusions appear to be warranted by what has been already stated:—

1. Self-fertilisation occurs but rarely, and, so far as evidence is available, the number of perfect seeds produced by self-fertilised flowers is extremely small.

2. The long-styled flowers of *F. excorticata* and *F. colensoi* are practically female flowers, but produce fruit more abundantly than either of the hermaphrodite forms.

3. The hermaphrodite forms are reciprocally related, and have a special relationship with the long-styled form.

The precise amount of advantage derived from the fertilisation of the long-styled form of *F. excorticata* with pollen from both mid- and short-styled forms can only be determined by a long and careful series of experiments. Some advantages must be obtained by the reduced demands upon the vital energy of the plant arising from the non-development of pollen.

As the mid- and short-styled forms of *F. procumbens* are not unfrequent under cultivation, it would be comparatively easy to ascertain the effects of intercrossing between these forms. The long-styled form is rare, and not easily obtained. It is most desirable that this form should be placed in the hands of the cultivator, since the species is unable to extend itself in a state of nature, and is gradually dying out; while

its extinction is hastened by the progress of settlement. I have been informed that it has already become extinct in Tryphena Bay.

It is remarkable that the differential characters of *F. colensoi* and *F. procumbens* have not been more fully defined: the original drawing of the long-styled form of *F. procumbens* was published in 1842, and the short-styled form (*F. kirkii*) in 1871. In the original "Flora Novæ-Zelandiæ," volume i., page 57, *F. colensoi* is evidently included under *F. procumbens*, although the flowers are said to be apetalous; and in the "Handbook of the New Zealand Flora," page 76, the flowers of *F. procumbens* are said to be "as in *F. excorticata*, but smaller." At page 728 *F. colensoi* is for the first time described as a distinct species, but very briefly. The Otago botanists have usually mistaken forms of *F. colensoi* for *F. procumbens*, although the erect flowers of the latter are alone sufficient to distinguish it from any other species. I venture, therefore, to give the following amended descriptions of the New Zealand species from the MSS. of the "Students' Flora of New Zealand," now in course of preparation:—

Fuchsia excorticata, Linné, Supp. 217.

A shrub or small tree 10ft.–45ft. high; trunk 6in.–3ft. in diameter, clothed with brown papery bark. Leaves alternate, 1½in.–4in. long, lanceolate or ovate-lanceolate, acute or acuminate, entire or obscurely toothed, membranous, silvery beneath; petioles short. Flowers axillary, solitary, ¾in.–1in. long, trimorphic, on filiform drooping peduncles; calyx globose at the base, then suddenly constricted and expanded into a funnel-shaped tube, with longitudinal ridges, segments 4, acuminate, spreading; petals very small; stamens exserted and, like the style, varying in length. Fruit a pendulous purple or black berry. Link *et* Otto, Abb., t. 46; Lindl. in Bot. Reg., t. 857; D. C., Prodr., iii., 39; A. Cunn., Precurs., n. 533; Raoul, Enum. Pl. Nov. Zel., 49; Hook. f., Fl. N.Z., i., 56; Handbk. N.Z. Fl., 75; T. Kirk, Forest Fl. N.Z., t. 36 and 36A. *Skinnera excorticata*, R. and G. Forster, Char. Gen., t. 29; A. Rich., Fl. Nov. Zel., 331. *Agapanthus calyciflorus*, Banks and Sol., MSS. Kotukutuku, konini (the fruit only).

Hab. On the margins of woods, &c., from the North Cape to Stewart Island. Ascends to 3,000ft. Flowers August to December.

In exposed or elevated situations this species is reduced to a dwarf bush. The branchlets are rather stout and very brittle. The petioles and peduncles vary greatly in length.

F. colensoi, Hook. f., Handbk. N.Z. Flora, 728.

A small erect or prostrate shrub with slender branchlets. Leaves alternate, ovate or orbicular-ovate, rounded or cordate at the base, acute, very membranous when dry, obscurely toothed, rarely silvery beneath; petioles very slender, longer or shorter than the leaves. Flowers as in *F. excorticata*, but the calyx-tube rather wider at the mouth, and the petals minute.

Hab. Lower Waikato, southward to Stewart Island; more frequent in the South. Ascends to 1,500ft. Flowers October to February.

This species is local in many districts, and always less abundant than the preceding; the flowers are never produced in such profusion. In some places the unbranched flexuous shoots are 8ft. or 9ft. long and subscandent; in others the entire plant scarcely exceeds a foot in height.

F. procumbens, R. Cunn., MSS. in A. Cunn., Precurs., n. 534.

Stems extremely slender, prostrate, 6in.–18in. long. Leaves alternate, rounded-ovate or cordate, obscurely toothed, ¼in.–½in. in length, shorter than the slender petioles. Flowers axillary, solitary, ½in.–¾in. long, on erect peduncles; calyx-tube funnel-shaped, without raised ridges, not dilated at the base; segments oblong, acute, recurved. Petals 0. Stamens equal; style varying in length, stigma capitate, four-lobed. Berry large, clavate, glaucous, bright-red. Hook., Ic. Pl., t. 421; Raoul, Enum. Pl. N.Z., 49; Hook. f., Fl. N.Z., i., 57; Handbk. N.Z. Fl., 76. *F. kirkii*, Hook. f., Ic. Pl., t. 1083.

Hab. North Island. In sandy or rocky places near high-water mark; rare and local. Matauri; Whangaruru; Cape Colville Peninsula; Great Barrier Island. November to February.

This appears to be the only species with erect flowers, and the only apetalous species with the calyx-tube destitute of external longitudinal ridges.

EXPLANATION OF PLATE XIX.

Fuchsia excorticata, L. f.

1. Long-styled form. 2. Mid-styled form. 3. Short-styled form.

Fuchsia colensoi, Hook. f.

4. Long-styled form. 5. Mid-styled form.

Fuchsia procumbens, R. Cunn.

6. Long-styled form. 7. Mid-styled form. 8. Short-styled form.
9. The same in longitudinal section.

ART. XXXII.—*Description of a New Genus and of New Species of Native Plants, &c.*

By D. PETRIE, M.A., F.L.S.

[*Read before the Otago Institute, 12th July, 1892.*]

Plate XX.

Natural Order BORAGINEÆ.

Tetrachondra,* genus novum.

FLORES parvi, tetrameri. *Calyx* persistens alte 4-fidus, segmentis ovatis obtusis; fructifer immutatus. *Corolla* subrotata calycem paullo superans, limbi segmentis ovatis, fauce esquamata, æstivatione imbricata. *Stamina* 4, sinubus corollæ inserta; filamentis brevibus antheræ subæquilongis; antheræ parvæ rotundatæ dorsifixæ, biloculares, inappendiculatæ. *Ovarium* 4-partitum; stylus inter lobos erectus ovario 2-plo longior; stigma parvum. *Nuculæ* sæpius 4 erectæ areola parva basilari affixæ, dorso et apice rotundatæ, setulosæ, inferne triangulares, calycem persistentem stylumque subduplo superantes. *Semina* erecta, albuminosa; embryo teres albumini subæquilongus, cotyledonibus radiculæ æquilongis. Herba *depressa, repens, glabra v. subglabra.* Folia *omnia opposita, parva, $\frac{1}{12}$–$\frac{1}{10}$ poll. longa, elliptica, obtusa v. obtusiuscula, integra, carnosula, obscure punctata; petioli latiusculi, plani, interdum parce setuloso-ciliolati, connati.* Flores *ramulos breves axillares foliiferos terminantes, sæpius solitarii.*

Tetrachondra hamiltonii, sp. un. Plate XX., figs. 8–11.

A slender, perennial, matted and creeping herb. Leaves gland-dotted, small, elliptic, obtuse, entire, glabrous, subsessile, in opposite pairs; petioles connate and shortly sheathing the stem.

Flowers axillary, minute, subsessile, solitary, the slender peduncle elongated and decurved in fruit. Other characters as in genus.

Hab. Wet clay hollows in fields at Waipahi; and wet grounds at Hindon and Sutton Creek (Strath Taieri). This remarkable plant clearly belongs to the order *Borragineæ;* but its position in the order must for the present remain uncertain. Mr. N. E. Brown, A.L.S., and Professor Oliver, of Kew, think

* Through the courtesy of the Secretary to the Institute I have been able to include the generic character, as published by Professor Oliver in the "Icones Plantarum." An excellent plate (No. 2250, Fourth Series, vol. iii.) accompanies the character.

it should be placed in the tribe *Borageæ*, next to *Eritrichium*, Schrad.; but its abundant albumen separates it sharply from the genera of this tribe, which are all ex-albuminous. I have a very slight acquaintance with this natural order, which is represented in New Zealand only by *Myosotis*, Linn., *Exarrhena*, Br., and *Myosotidium*, Hook., in addition to the genus here described, and I shall therefore offer no opinion as to its position in the order. Mr. Brown informs me that my plant is identical with *Tillæa hamiltonii*, T. Kirk, noticed in a paper by Mr. W. S. Hamilton in volume xvii., page 292, of the Transactions of the New Zealand Institute, specimens of which Mr. T. Kirk, F.L.S., had sent to the Kew Herbarium. Mr. Kirk's specimens were very imperfect; otherwise I should not have had the opportunity of bringing this interesting new genus under your notice. To avoid useless synonymy I have retained the specific name proposed by Mr. Kirk.

Tillæa novæ-zelandiæ, sp. nov.

A short, slender, matted species, with the stems erect and 1in. long, or prostrate and rooting when they reach a length of 2in. or more. Leaves linear, acute, opposite, connate at the base. Flowers axillary, solitary, small, shortly peduncled, 4-merous. Sepals coherent at the base. Petals ovate, acute, longer than the calyx. Stamens alternate with the petals. Scales linear, thin, flat. Style long, reflexed. Seeds, two or three in each carpel.

Hab. Waipahi, Lake Waihola, Lake Te Anau.

The specimens from Waipahi are taken as the type. Those from Lake Waihola are more robust and creeping. The Te Anau ones are very slender, and have fewer, shorter, and narrower leaves. Mr. N. E. Brown, A.L.S., of Kew, informs me that he cannot detect scales in the specimens I forwarded to the Royal Herbarium; but they are constantly present, and can be readily found in the bud and in newly-opened flowers. They are not so easy to detect in older, and especially in dried, flowers, in which they may be readily overlooked or mistaken for parts of the filaments. In some respects the present species resembles *Tillæa debilis*, Colenso, but the scales and the much longer petals readily distinguish it from that species. It is not so slender or densely matted as *Tillæa sinclairii*, Hook. f.

Azorella nitens, sp. nov.

A small, creeping, matted, glossy-green plant, the scapes and petioles usually buried in the soil for quite half their length. Leaves broadly-cuneate in outline; usually three-partite to the base, rarely shortly three-lobed; the segments

$\frac{3}{16}$in. long, ovate-oblong, obtuse, entire, thickened at the margin; petiole slender, 1in. to 2in. long.

Scapes as long as the leaves, bearing one to three leaf-like petiolate bracts at the middle, where they usually subdivide into two or three branches. Umbels few-flowered (flowers 2 or 3); involucral bracts short, linear, acute; pedicels as long as the fruits or shorter. Fruits turgid, rounded at the back, broader than thick, deeply grooved between the mericarps, $\frac{1}{16}$in. long; ribs absent or very indistinct.

Hab. Shores of Lake Te Anau and banks of Clinton River (700ft.–1,000ft.). The small number of flowers in the umbel, the turgid almost ribless carpels, and the leaves three-partite to the base, mark this species off from all its congeners in New Zealand. In habit it much resembles *Hydrocotyle muscosa*, Br.

Lagenophora linearis, sp. nov.

A minute plant, with numerous entire, flat, glabrous, narrow-linear leaves, $\frac{1}{4}$in. to $\frac{3}{4}$in. long.

Scapes very slender, solitary or several, about twice as long as the leaves, elongating in fruit to nearly thrice their length.

Involucral scales broadly-oblong with dark-purple tips; flowers as long as the involucre. Heads broader than long, minute, $\frac{1}{16}$in. in length; receptacle flat, rather broad. Achenes compressed, linear, tapering at both ends.

Hab. Grassy flats on the shores of Lake Te Anau. A very inconspicuous plant, easily overlooked if not in flower.

Carmichælia curta, sp. nov.

A slender, sparingly-branched shrub about 2ft. high; branches dichotomous, subcompressed, grooved and striate, glabrous; leaves not seen. Flower-clusters alternate on the shoots, erect, racemose, 8–10-flowered, with pilose peduncles and pedicels; flowers $\frac{1}{8}$in. long, on pedicels as long as the calyx. Calyx more or less pilose, campanulate, shortly toothed, usually with two small bracts at the base. Corolla rather large, creamy-yellow striped with purple; the standard longer than the wings, broad, very obtuse. Ovary more or less pilose.

Ripe pods almost or quite glabrous, when immature generally pilose, $\frac{1}{8}$in. long; beak half the length of the pod, subconical, sharply curved towards the tip; pods thin, two- or three-seeded; seeds subreniform, usually pale-green with dark spots and blotches.

Hab. Waitaki River, at Duntroon and Kurow. The present species is most closely allied to *C. juncea*, Colenso. The flowers are, however, twice as large as in that species, the racemes

more pilose, the young pods generally pilose, and the pods and seeds nearly twice as large. In *C. juncea*, Col., the seeds are smaller, rounder, and more elongated. Flowering and fruiting specimens were gathered in the month of March.

Carmichælia diffusa, sp. nov.

A low, slender, semi-erect, branched shrub.

Branches slender, grooved and striate, narrow, compressed, glabrous.

Racemes short, of 6 or fewer flowers, springing from the axil of a prominent white scale. Flowers $\frac{1}{8}$in. long, on short pilose pedicels. Calyx glabrous, undulate and jagged or ciliate at the margin which is hardly toothed; ovary glabrous; pedicels not longer than the flowers.

Pods four or fewer in each raceme, $\frac{1}{8}$in. long, $\frac{1}{10}$in. wide, bluntly and broadly obovate, abruptly narrowed into a very short, straight, subulate beak continuous with the upper half of the pod; inner surface of pod puberulous, not cottony; replum strong; sides thick, slightly wrinkled, at length falling away, leaving the seed attached to the replum as in *C. australis*, Br. Seeds usually solitary, rarely two in a pod, large ($\frac{1}{11}$in. long, $\frac{1}{15}$in. broad), subterete, stouter at one end, yellow-brown with dark-green or blackish spots.

Hab. East coast of Otago, near the mouth of the Otepopo River. The pod of this species is very characteristic. It resembles that of *C. corymbosa*, Colenso, and some states of *C. flagelliformis*, Col., but is shorter, smaller, and broader at the apex. The seeds are much larger than in *C. flagelliformis*, and are not detached when the sides of the pod fall away.

Ourisia prorepens, sp. nov.

Stems slender, creeping and rooting, more or less branched, 4in. long or less.

Leaves loosely bifariously imbricate, $\frac{1}{2}$in. long, $\frac{1}{4}$in. to $\frac{1}{3}$in. broad, obovate, crenate, obtusely rounded at the apex, contracted into a broad thin petiole one-third the length of the blade, densely glandular-pilose above, slightly glandular-pilose below, not recurved at the margin; veins distinct on the undersurface.

Scapes slender, 4in. high or less, slightly glandular-pubescent; bracts in pairs, leaf-like, crenate or shortly lobed, nearly glabrous; flowers 3 to 6, solitary, on slender petioles 1in. to $1\frac{1}{2}$in. long. Calyx $\frac{1}{4}$in. long, divided to the middle into five oblong, obtuse, glandular-pubescent, and finely-ciliate lobes. Corolla large, $\frac{3}{4}$in. long and broad, the tube nearly twice as long as the calyx. Style very slender, twice as long as the calyx. Ripe fruit not seen.

Hab. Mount Bonpland, 4,000ft. The present species is somewhat closely allied to *O. glandulosa*, Hook. f., differing in the larger crenate leaves, the longer and more slender scape and peduncles, the larger and longer flowers, the crenate or shortly-lobed bracts, and the slight pubescence of the scape, bracts, and flowers.

Carex novæ-zelandiæ, sp. nov.

A short reddish-brown species, forming small tufts with stiff erect leaves that are curled at the tips. Culms, 4in. high or less, leafy, slender, terete, smooth. Leaves, always as long as, and usually longer than, the culms, very narrow, plano-convex, or concave above and convex below, smooth above, striate on lower surface, stiff, rather obtuse, curled and twisted at the tip.

Spikelets 4 or 5, $\frac{1}{5}$in. long, rather stout, erect, the lowermost usually distant, the others crowded, sessile or shortly-peduncled; uppermost spikelet male only, the rest female with a few male flowers at the base; bracts as long as the leaves, leaf-like.

Glumes membranous, broadly-ovate, entire, rather obtuse, nerved and apiculate.

Utricle biconvex, smooth or faintly ribbed, gradually and equally narrowed at either end, red-brown; beak smooth, hardly bifid.

Style-branches, two.

Hab. Boggy ground at the edge of Lake Te Anau. Gathered February, 1892.

This plant has much the same appearance as *Carex petriei*, Cheeseman; the twisted and curled tips of the leaves readily mark it off from all the other native species. From *C. petriei* it differs in having two style-branches, much shorter spikelets, narrower and more rigid leaves, and less turgid utricles.

Gastrodia minor, sp. nov. Plate XX., figs. 5–7.

A much smaller and more slender plant than *Gastrodia cunninghamii*, Hooker fil. Stems 8in. to 15in. high, terete, polished, $\frac{1}{12}$in. to $\frac{1}{16}$in. in diameter near the base; scales few, forming short oblique subacute sheaths round the stem, the upper ones distant; the whole plant except the tips of the flowers of a uniform umber-brown colour, not spotted.

Racemes 1in. to 3in. long, of 1 to 9 pendulous flowers (usually 3 to 5). Bracts short, rather broad, scarious. Pedicels slender, 2 lines long; ovary as long as the pedicel, ribbed, slightly tuberculate. Perianth 5 lines long, ventricose, 5-fid, the very narrow division behind the labellum extending to about one-third the length of the tube, the others

very shallow (less than 1 line deep); the sepals and two inferior petals rounded, undulate, crumpled and incurved along the thickened margin; tips and inner surface of the perianth-lobes dirty-white.

Labellum, included, oblong, dull-yellow, sometimes slightly expanded at the base, with two subpapillose narrow more or less confluent medial ridges, incurved and thickened at the undulating and crumpled margin; the upper third free, the lower half adnate to the tube and with or without obscure ridge-like wings at the sides.

Column short, with straight very short lateral appendages that are either acute or obtuse.

Hab. Town Belt, Dunedin, in shady manuka bush. Flowers first weeks of January.

The present species differs from *G. cunninghamii*, H. f., in its small size, short racemes, smaller flowers, and umber-brown colour, but most of all in the structure and attachment of the labellum. Mr. A. Hamilton has kindly drawn for me the flowers of both species, and his drawings show the points of difference plainly enough. In *G. cunninghamii* (Plate XX., figs. 1–4) the free part of the labellum is trowel-shaped and much thinner at the sides than in my plant, and it has a distinct claw which is wanting in *G. minor*. The curiously-twisted wing of the lower part of the labellum of the former is wholly absent in the present species, in which, moreover, all the divisions of the flower except the labellum are of equal length. The lateral appendages of the column in *G. cunninghamii* are slender, curved, and horn-like; in *G. minor* they are short, erect, and straight. I had the good fortune to find both plants in flower in the neighbourhood of Dunedin at the same time, so that a very complete comparison of the two species was practicable. The flowers of the present species open but very slightly, and the groove behind the labellum cannot be seen without pushing apart the sepals which the latter separates.

Gunnera ovata, sp. nov.

Rhizome creeping, tufted.

Leaves broadly-ovate, obtusely rounded at the tip and cordate or subcordate at the base, finely crenately toothed all round the margin, nearly glabrous or with short scattered pale hairs, about 1in. long and ¾in. broad. Petiole slender, glabrous or more or less clothed with short pale hairs, twice as long as the blade.

Flowers on peduncles about ½in. long, lengthening in fruit to 1½in. Male flowers in a slender interrupted spike 2in. to 3in. long; female flowers forming a dense oblong spike about ⅓in. long. Fruiting spike ¾in. long, rather slender; drupes

$\frac{1}{8}$in. long, sessile, turbinate, dark-red, placed at right angles to the peduncle, not pendulous.

Hab. South Island—Lake Te Anau; Catlin's River; mouth of the Clutha; Hindon; and Kaikorai (Dunedin). North Island—Near Erehwon (Upper Rangitikei). I hear from Mr. N. E. Brown, of Kew, that this species is the plant, gathered near the base of Tongariro by Colenso, and in the South Island by Dr. Lyall, to which Sir Joseph Hooker refers at page 68 of the Handbook as a probable fourth species of *Gunnera.* It grows only in ground saturated for most of the year with water, and is generally accompanied by masses of *Sphagnum.*

Agrostis multicaulis, Hook. f.

This species was gathered by me in January of the present year at the head of the Clinton Valley (Te Anau). It is a native of Campbell Island, and has now been met with for the first time on the mainland of New Zealand. I am not sure that there are sufficient grounds for merging this species in *A. antarctica,* Hook. f., as Sir Joseph Hooker has done in the "Handbook of the New Zealand Flora." At any rate, the plant from the Clinton Valley differs widely from that figured as *A. antarctica,* Hook. f., in vol. ii. of the "Flora Antarctica."

EXPLANATION OF PLATE XX.

1. Flower of *Gastrodia cunninghamii,* Hook. fil.
2. Column and labellum of ditto.
3. Column and appendages of ditto (enlarged).
4. Perianth of ditto laid open.
5. Part of spike of *Gastrodia minor.*
6. Column of ditto.
7. Perianth of ditto laid open.
8. Flowering branch of *Tetrachondra hamiltonii* (enlarged).
9. Corolla of ditto laid open.
10. Flower of ditto, the corolla and front lobes of the calyx removed.
11. Fruit of ditto.

Art. XXXIII.—*Notes on the New Zealand Species of the Genus* Andreæa, *together with Descriptions of some New Species.*

By R. Brown.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1892.*]

Plates XXI.–XXXI. (in Part).

The following account of the genus *Andreæa* as it occurs in New Zealand is a portion of the results of ten years' work, studying and collecting the *Musci* of New Zealand in their native habitats, and figuring the various species and varieties with the camera lucida. All the plants described have been collected by myself, many of them in localities previously unbotanized, notably the Clinton Pass, Sutherland Falls, South Fjord of Lake Te Anau, in Otago; Moa Creek, Walker's Pass, the Craigieburn and Puketeraki Mountains, in Canterbury; and the western slopes of the Southern Alps in Westland; together with Mount Thompson and the Ruggedy Mountains in Stewart Island. I am with reluctance approaching this subject prematurely, much remaining yet to do, but from circumstances which have recently transpired I am forced to do so in order to protect my own rights; for, acting on the suggestion of the late Sir Julius von Haast, I presented nearly all my specimens and camera-lucida drawings to the Christchurch Museum, where they remain for any one to describe who may think fit to rob me of my hard-earned rights.

The genus *Andreæa* in New Zealand, as in other countries, comprises species of an alpine or subalpine character, only growing under an elevation of 2,000ft. when exposed to a constant stream of moist air in exceptionally cold localities. They are found in rocky situations, often growing under great difficulties, their roots fixed in rocky depressions, which after rain retain a few drops of moisture, exposed at the same time to the full heat of the sun, and to periods of drought which would utterly destroy them were they not possessed of the power to extract moisture from the air. I have often, when collecting these plants in dry weather, had to moisten them with saliva, whereupon the apparently dead plant, owing to its hygrometric leaves, would revive. With regard to the leaves, those found about the middle of the stem have in many of the species much resemblance to each other, varying principally in breadth and obliqueness. This is very perplexing, so I have adopted the plan of figuring all the leaves from base to apex of the plant, including the perichætial,

these latter being of the greatest importance in the determination of species. Following this plan, a graduated series is found in the shape of the leaves, beginning with those at the base and running up to the perichætial. Thus, I do not think there should be any difficulty in recognising the new species here described.

All the Andreæas described in the Handbook are figured in the "Flora Antarctica" except *Andreæa petrophila*, and are there available for reference. To complete the series, I have added drawings of *A. petrophila*, taken from a Swedish specimen (Pl. XXXI.). The perichætial leaves are large in all the New Zealand species except *A. subulata*, in which they are described in the Handbook as small and inconspicuous. This plant I have never seen. These leaves play an important part in protecting the young capsule from being destroyed by great extremes of temperature. In three of the species the vaginula has been found sessile and the spores appeared to have matured, while on the same plants were found the remains of the previous year's capsule with a stalked vaginula, showing that this stalk had been subsequently developed. With regard to distribution, some of the species are very common, while others are extremely local, *A. aquaticus* and *A. aquatilis* having been found in one locality only.

The following arrangement of the species of this genus in its enlarged state is that adopted by Sir J. D. Hooker in the Handbook, and is intended to place the plants in the position they relatively hold. In the present condition of the genus it is perhaps the best, as it is not known how many of the species are diœcious:—

Nerveless.

A. acutifolia, *Hook. and Wils.*
A. gibbosa, *sp. nov.*
A. petrophila, *Ehrh.*
A. dioica, *sp. nov.*
A. minuta, *sp. nov.*
A. novæ-zelandiæ, *sp. nov.*
A. wrightii, *sp. nov.*
A. mutabilis, *Hook. f.*
A. flexuosa, *sp. nov.*
A. huttoni, *sp. nov.*
A. nitida, *Hook. and Wils.*
A. aquatica, *sp. nov.*

Nerved.

A. subulata, *Harv.*
A. dicranioides, *sp. nov.*
A. ovalifolia, *sp. nov.*

A. apiculata, *sp. nov.*
A. cockaynei, *sp. nov.*
A. jonesii, *sp. nov.*
A. clintoniensis, *sp. nov.*
A. lanceolata, *sp. nov.*
A. aquatilis, *sp. nov.*

Andreæa gibbosa, sp. nov. Plate XXI.

Plants small, densely tufted, about $\frac{1}{4}$in. high, fastigiately branched. Leaves dark reddish-brown, small, densely imbricating, erecto-patent, slightly incurved towards the tips, subulate-lanceolate, acute, concave, sheathing and gibbous at the base, margins entire, nerveless; perichætial large, erect, not gibbous at base, inner pair elliptic-lanceolate, acute, convolute, sheathing, outer pair lanceolate, acute, nerveless, minutely papillose.

Hab. Moa Creek, on rocks; June, 1885. Port Hills; 1883.

Andreæa dioica, sp. nov. Plate XXI.

Plants very small and densely tufted. Stem from $\frac{1}{8}$in. to $\frac{1}{4}$in. long, fastigiately branched. Leaves brownish-green, lower extremely small, deltoid, acute, becoming larger immediately below the perichætial leaves, then ovate-subulate, acute, very concave, margins entire, nerveless, minutely papillose on the back, appressed when dry; perichætial large, erect, ovate-lanceolate, obtuse, slightly cucullate, semi-convolute, margins incurved. Capsule subrotund, apiculate. Diœcious.

Hab. On rocks, Moa Creek; June, 1885.

Andreæa minuta, sp. nov. Plate XXI.

Plants very small, densely tufted. Stem $\frac{1}{16}$in. long or more, fastigiately branched. Leaves brown, erecto-patent, imbricating, ovate-subulate, acute, oblique, margins entire or minutely papillose near the apex, nerveless, concave, papillose on the back, appressed when dry; perichætial larger, erect, outer pair larger than the inner, semi-convolute, broadly oblong-lanceolate, acute, inner pair ovate-lanceolate, acute, nerveless, papillose.

Hab. On rocks, Moa Creek; June, 1885.

Andreæa novæ-zelandiæ, sp. nov. Plate XXII.

Plants small, densely tufted. Stem from $\frac{1}{4}$in. to $\frac{1}{2}$in. long, fastigiately branched. Leaves dark red-brown, erecto-patent, slightly incurved, *lower* subulate-lanceolate, acute, *upper* narrow ovate-lanceolate, acuminate, concave, margins entire, nerveless, appressed when dry; perichætial large, erect, broadly-ovate or oblong-acuminate, slightly incurved near the apex, outer pair convolute, inner pair narrower, concave.

Hab. On rocks, Moa Creek; 1885.

Andreæa wrightii, sp. nov. Plate XXII.

Plants small, densely tufted, ¼in. long, nearly naked below, fastigiately branched. Leaves closely imbricating, erecto-patent, *lower* scale-like, *middle* small, varying from subulate-lanceolate to narrow ovate-lanceolate, acute, *upper* larger, concave, nerveless, papillose, margins entire; perichætial large, erect, semi-convolute, outer and inner pair sheathing two-thirds of their length, oblong-lanceolate and narrowed into an obtuse cucullate apex, nerveless, appressed when dry. Capsule ovate-apiculate.

Hab. Rocks, Moa Creek; June, 1885. Dedicated to Mr. Thomas G. Wright, of Christchurch, an earnest cryptogamic botanist.

Andreæa mutabilis, Hook. f. and Wils. (Enlarged and revised description.) Plate XXII.

Plants densely tufted. Stem ¼in. to 1in. high, branched. Leaves dark red-brown, erecto-patent, *lower* deltoid-subulate, acute, *middle* ovate-lanceolate, tapering into an acute point, *upper* ovate-subulate, acute, concave, margins entire, nerveless, papillose on the back, often falcate, appressed when dry; perichætial larger, erect, sheathing, convolute, ovate-lanceolate, acuminate, nerveless, incurving near the apex.

Var. *β*. All the upper-stem leaves hamulose.

Hab. Port Hills; Craigieburn Range, Arthur's Pass, Moa Creek. Var. *β*. Clinton Valley, Otago.

Andreæa flexuosa, sp. nov. Plate XXIII.

Plants densely tufted. Stem from ¼in. to ¾in. long, fastigiately branched. Branches short. Leaves erecto-patent, imbricating, dark-brown, flexuous, sheathing near the base, linear-lanceolate, acute, concave, margins entire, nerveless, appressed when dry; perichætial erect, sheathing, convolute, obliquely ovate-subulate, obtuse, slightly cucullate at the apex, nerveless.

Hab. Arthur's Pass, on rocks; June, 1884. Moa Creek; June, 1885.

Andreæa huttoni, sp. nov. Plate XXIII.

Plants growing in small loose tufts. Stems from ¼in. to ½in. long, branched. Leaves red-brown, closely imbricating, erecto-patent, *lower* small, ovate-subulate, obtuse, oblique, *middle* ovate-lanceolate, obtuse, oblique margin incurved above the middle, cucullate at the apex, *upper* larger, nerveless, margins entire, concave; perichætial erect, large, sheathing nearly three-fourths of their length, convolute, narrowed into an obtuse cucullate apex, nerveless, closely appressed when dry. Capsule small.

Hab. Rocks, Moa Creek; 1885. Named in honour of Professor Hutton, of Christchurch.

Andreæa aquatica, sp. nov. Plates XXIII. and XXIV.

Plants growing in large loose tufts from 1in. to 4in. long. Branches flexuous, long. Leaves large, spreading, very crisp, brownish-green, glossy, *middle* broadly-ovate or subrotund, *upper* broadly ovate-acuminate, concave, margins entire, nerveless, scarcely altered when dry; perichætial very large, erect, *outer* lanceolate, acuminate, concave, *inner* sheathing, convolute, oblong-lanceolate, acuminate, incurved from the middle, nerveless. Capsule very large.

Hab. Growing submerged in water on stones in a small stream on Kelly's Hill, Westland, at an altitude of 3,500ft.; November, 1889.

The most beautiful of all the New Zealand Andreæas, being finely crisped, and of a shining brown and green colour.

Andreæa dicranioides, sp. nov. Plate XXV.

Plants growing in dense tufts, fastigiate, ⅓in. to ¾in. long. Leaves red-brown, imbricating, secund, strongly falcate, base concave, narrowly-ovate or linear, tapering rapidly into a long slender point four-fifths of the length of the leaves, nerve slender, sometimes nearly absent. Specimen not in fruit.

Hab. Rocks on side of small tarn below Lake Mintaro, Clinton Valley; 1889.

Andreæa ovalifolia, sp. nov. Plate XXV.

Plants growing in dense tufts from ¼in. to 2in. long. Stems slightly fastigiately branched. Leaves spreading, large, dark-brown, scale-like at the base, *middle* oval, *upper* oval, shortly acute or broadly ovate-acute, concave, nerve broad ending about middle, margins entire, appressed when dry; perichætial large, erect, broadly-ovate, ending in a small point, margins entire, nerveless.

Hab. Port Hills, on rocks; October, 1883. Mount Torlesse; January, 1886. Waimakariri glaciers; 1890. Mount Bosquet; 1888.

Andreæa apiculata, sp. nov. Plate XXVI.

Plant loosely tufted, from 1in. to 1½in. long, slightly branched. Branches slender, fastigiate. Leaves erecto-patent, brownish-green, shining, *lower* scale-like, *middle* ovate-oblong or obovate, rounded into a short acute point, concave, nerve disappearing near the middle, margins entire, upper very large, broadly-lanceolate, acute, nerve disappearing at the middle, margins entire, very concave, appressed when dry;

perichætial erect, large, sheathing, convolute, cucullate at apex. Capsule large.

Hab. Precipitous rocks forming one side of a small tarn below Lake Mintaro, Clinton Valley; January, 1890.

Andreæa cockaynei, sp. nov. Plate XXVII.

Plants growing in dense tufts. From ½in. to 1in. long, fastigiately branched. Leaves erecto-patent, densely imbricating, yellow-brown at the tips of the branches, dark-brown below, *lower* minute, ovate-subulate or ovate-cordate, falcate, nerved to the apex, concave, margin entire, *middle and upper leaves* oblong-lanceolate, tapering rapidly into a long slender point, slightly falcate, concave, nerveless. Immediately outside the perichætial are a few large leaves, oblong-ovate, rounded into a short or long point, concave, nerveless, appressed when dry; perichætial leaves erect, sheathing, oblong or elliptic-lanceolate, acuminate, convolute, nerveless. Capsule small.

Hab. Rocks side of small tarn below Lake Mintaro, Clinton Valley, Otago. Named in honour of Mr. L. Cockayne, my botanical companion in many rough journeys among the mountains.

Andreæa jonesii, sp. nov. Plates XXVIII. and XXIX.

Plants densely tufted, from ¼in. to ½in. long. Stems flexuous, simple or slightly branched, fastigiate. Leaves erecto-patent, red-brown, closely imbricating, *middle* ovate-lanceolate, rapidly tapering into a long slender point for about two-thirds the length of the leaf, *upper* large, broadly oblong-lanceolate, rapidly tapering into a long point for one-third the length of the leaf, straight or slightly falcate, margin entire, concave, nerved; perichætial, *inner pair* elliptic-lanceolate, gradually tapering into a slender point, convolute, sheathing, *outer* larger, oblong-lanceolate, rapidly constricted into a slender point, convolute. Diœcious, leaves of male plant strongly falcate.

Hab. On rocks, Moa Creek; June, 1885.

Var. β. Upper leaves shorter in the blade and the point longer in proportion; perichætial larger and the capsule smaller than in the type.

Hab. Rocks on Mount Torlesse; January, 1886. Rocks above Robinson's Bay, Banks Peninsula. Named after the late F. Jones, Esq., M.H.R.

Andreæa clintoniensis, sp. nov. Plate XXIX.

Plant densely tufted, from ½in. to 1in. long. Stems simple or sparingly branched, fastigiate. Leaves yellow-brown near apex of branch, dark-brown below, erecto-patent, slightly incurved, *lower* linear-lanceolate, acute, *upper* ovate or oblong-

lanceolate, acute, margins recurved, nerved to apex, appressed when dry; perichætial about same length as upper leaves, semiconvolute, ovate-lanceolate, acuminate, nerved to apex. Capsule ovate.

Hab. Rocks on side of tarn below Lake Mintaro, Clinton Valley, Otago; 1889.

Andreæa lanceolata, sp. nov. Plate XXX.

Plants growing in dense tufts about 1in. high. Stems simple or fastigiately branched. Leaves brownish-green, large, spreading, appressed when dry, incurved towards the apex, loosely imbricating, oblong-lanceolate, acute, nerved to the apex, margin recurved, concave, smaller towards base; perichætial large, erect, concave, *inner* smaller, apex of leaves inflexed over the capsule. Capsule ovate.

Hab. Moa Creek, on rocks; June, 1885.

Andreæa aquatilis, sp. nov. Plate XXX.

Plants large, loosely tufted, from 2in. to 5in. long. Stem flexuous, sparingly branched. Leaves very dark-brown, spreading, incurved from the middle towards the apex, *lower* small, lanceolate, acute, *upper* shortly ovate-lanceolate, acute, concave, margin entire, nerved to the apex, loosely appressed, shrivelled when dry; perichætial large, erect, *outer* broadly lanceolate-acuminate, concave, nerved to the apex, *inner* smaller. Capsule very large, broadly ovate.

Hab. On stones in a small tarn, submerged in the water, towards summit of Kelly's Hill, Westland.

DESCRIPTION OF PLATES XXI.–XXXI. (IN PART).

PLATE XXI.

Figs. *Andreæa gibbosa*, sp. nov.

1, 2. Lower stem leaves.
3, 4, 5. Middle and upper stem leaves.
6. Tip of a branch.
7, 8. Outer pair of perichætial leaves.
9, 10. Inner pair of perichætial leaves.

Andreæa dioica, sp. nov.

1, 2. Lower stem leaves.
3, 4. Middle stem leaves.
5. Upper stem leaf.
6. Outer perichætial leaf.
7. Inner perichætial leaf and capsule.

Andreæa minuta, sp. nov.

1, 2. Lower stem leaves.
3, 4. Middle and upper stem leaves.
5, 6. Outer pair of perichætial leaves.
7, 8. Inner pair of perichætial leaves.

Plate XXII.

Figs. *Andreæa novæ-zelandiæ*, sp. nov.

1, 2. Lower stem leaves.
3, 4. Middle and upper stem leaves.
5, 6. Outer pair of perichætial leaves.
7, 8. Inner pair of perichætial leaves.

Andreæa wrightii, sp. nov.

1, 2, 3. Lower stem leaves.
4, 5, 6. Middle and upper stem leaves.
7. Outer pair of perichætial leaves.
8, 9. Inner pair of perichætial leaves and capsule.

Andreæa mutabilis, Hook. f.

1, 2. Lower stem leaves.
3. Middle stem leaf.
5. Upper stem leaf.
4, 6. Outer pair of perichætial leaves.
7, 8. Inner pair of perichætial leaves.

Plate XXIII.

Figs. *Andreæa flexuosa*, sp. nov.

1, 2, 3, 4. Middle stem leaves.
5. Upper stem leaf.
6. Outer perichætial leaf.
7. Inner perichætial leaf and capsule.

Andreæa huttoni, sp. nov.

1. Lower stem leaf.
2. Middle stem leaf.
3. Upper stem leaf.
4. Outer perichætial leaf.
5. Inner perichætial leaf.
6. Capsule.

Andreæa aquatica, sp. nov.

1. Lower stem leaf.
2. Middle stem leaf.
3. Upper stem leaf.

Plate XXIV.

Figs. *Andreæa aquatica*, sp. nov.

1. Outer perichætial leaf.
2. Inner perichætial leaf.
3. Capsule.

Plate XXV.

Figs. *Andreæa dicranioides*, sp. nov.

1, 2. Lower stem leaves.
3, 4, 5. Middle stem leaves.
6. Upper stem leaf.
7. Tip of a branch.

Andreæa ovalifolia, sp. nov.

1, 2. Lower stem leaves.
3, 4. Middle and upper stem leaves.
5. Outer perichætial leaves.
6. Inner perichætial leaves.

PLATE XXVI.

Figs. *Andreæa apiculata*, sp. nov.

1, 2. Middle stem leaves.
3. Upper stem leaf.
4. Outer perichætial leaf.
5. Inner perichætial leaf and capsule.

PLATE XXVII.

Figs. *Andreæa cockaynei*, sp. nov.

1, 2. Lower stem leaves.
3, 4. Middle stem leaves.
5, 6. Upper stem leaves.
7, 8. Leaves immediately outside the perichætial.
9. One of outer pair of perichætial leaves.
10. Inner pair of perichætial leaves and capsule.

PLATE XXVIII.

Figs. *Andreæa jonesii*, sp. nov.

1, 2. Middle stem leaves.
3. Upper stem leaf.
4, 5. Outer pair of perichætial leaves.
6, 7. Inner pair of perichætial leaves.
8. Capsule.

PLATE XXIX.

Figs. *Andreæa jonesii*, sp. nov., var. *β*.

1, 2. Middle stem leaves.
3. Upper stem leaves.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Capsule.

Andreæa clintoniensis, sp. nov.

1, 2. Middle stem leaves.
3. Upper stem leaf.
4. Outer perichætial leaf.
5. Inner perichætial leaf and capsule.

PLATE XXX.

Figs. *Andreæa lanceolata*, sp. nov.

1. Lower stem leaf.
2, 3. Middle stem leaves.
4. Upper stem leaf.
6. Outer perichætial leaf.
5. Inner perichætial leaf.
7. Capsule.

Andreæa aquatilis, sp. nov.

1, 2. Lower stem leaves.
3. Upper stem leaf.
4. Middle stem leaf.
5. Outer perichætial leaf.
6. Inner perichætial leaf.
7. Capsule.

PLATE XXXI. (in Part).

Figs. *Andreæa petrophila*, Ehrhart.
1, 2. Middle stem leaves.
3, 4. Upper stem leaves.
5. Inner perichætial leaf.

ART. XXXIV.—*Notes on a Proposed New Genus of New Zealand Mosses; together with a Description of Three New Species.*

By ROBERT BROWN.

[*Read before the Philosophical Institute of Canterbury, 7th September, 1892.*]

Plates XXXI. (in Part) to XXXIII.

DURING the year 1882, having been engaged in botanizing on the Port Hills, from the lighthouse at the Heads to Cooper's Nob at the opposite end of the harbour, and on the plains round Christchurch as far as the banks of the River Waimakariri, amongst a number of new mosses then discovered by me were three which could not be placed in any of the existing genera, they, however, being most nearly related to *Encalypta*, yet differing from that genus in their having a *short*, *stout*, straight beak, instead of a *long*, *slender*, straight beak, while the calyptra, instead of being inflated as in that genus, closely encloses the capsule, and is confluent at the base. Since these two generic characters are the very opposite to those of *Encalypta*, these plants cannot be very well placed in that genus without seriously disturbing the accepted generic characters; consequently it becomes necessary that a new genus should be created to receive these mosses. Acting on the advice of a friend, I took no steps in this matter at the time for creating a new genus, fearing that the above-mentioned mosses might prove to be examples of some foreign genus not represented in the New Zealand flora; however, since this has proved to be not the case, I have brought this subject before the Institute to-night, and propose to name the new genus after the late Rodger Hennedy, Professor of Botany at the Andersonian University, Glasgow, my late admirable teacher and esteemed friend.

HENNEDIA, Gen. Nov.

Annual or perennial plants. Capsule erect or inclined, ovate or ovate-oblong, symmetrical, narrowed towards the mouth. Operculum short, stout, conic, straight. Calyptra

mitriform, large, covering the whole capsule, confluent at the base, commonly ruptured at the middle by the lateral growth of the capsule, when maturing very persistent. Peristome none.

Hennedia macrophylla, sp. nov. Plate XXXI.

A densely-tufted pale-green perennial moss, about $\frac{1}{2}$in. high. Stem short, fastigiately branched. Leaves nearly erect, oblong-lanceolate, apiculate, slightly narrowed in the middle, concave, slightly recurved near the apex, margined with a subpellucid border of long quadrate cells, serrated towards the apex, from $\frac{3}{16}$in. to $\frac{1}{4}$in. long, upper leaves longest, crisp when dry. Nerve keeled, excurrent. Areola, upper half dense, round; lower half quadrate, pellucid. Perichætial leaves similar to the other leaves. Capsule *immersed*, hidden by the upper leaves, broadly-ovate, narrowed into the mouth. Operculum short, conic, straight. Calyptra mitriform, large, tightly covering the whole capsule, confluent at the base, and very persistent.

Hab. Banks of the River Avon, near Christchurch. Fruiting from August to November.

Hennedia intermedia, sp. nov. Plate XXXII.

Plants growing in small patches, dark-green, about $\frac{1}{4}$in. high. Stem short, $\frac{1}{16}$in. or less, branched near the base. Leaves spreading, lower ovate-lanceolate, apiculate; upper larger, oblong-lanceolate, acute or acuminate, apiculate, serrated towards the apex, as long as or longer than the fruitstalk. Margin with a narrow border of pellucid quadrate cells, nerve percurrent. Areolæ—at the base, large quadrate, membranous; upper roundish. Perichætial leaves longer, otherwise similar. Fruitstalk $\frac{1}{8}$in., inclined, thickened upwards. Capsule exserted, ovate-oblong, narrowed into the mouth. Operculum short, straight, conic. Calyptra mitriform, large, closely enclosing the capsule and confluent at the base, very persistent.

Hab. Damp banks, Port Hills, and plantations round the River Avon.

Hennedia microphylla, sp. nov. Plate XXXIII.

A small, annual, pale-green moss, whole plant from $\frac{2}{16}$in. to $\frac{5}{16}$in. high. Simple or branched near the base. Leaves spreading, concave, oblong-lanceolate, acuminate. Margin entire or slightly toothed near the apex. Nerve vanishing or excurrent. Margin with a narrow border of quadrate cells. Perichætial leaves similar to stem-leaves, but slightly longer. Fruitstalk longer than the leaves, thickened upwards. Capsule inclined, ovate-oblong, narrowing towards the mouth. Operculum

conic, straight, short. Calyptra mitriform, closely enclosing the capsule and confluent at the base, very persistent.

Hab. Damp banks in the neighbourhood of Christchurch. Common; fruiting from September to December.

With regard to the determination of these three species, *H. macrophylla* is quite distinct; but the similarity between *H. intermedia* and *H. microphylla* is so marked that I was very reluctant to make the latter anything but a variety of the former. But, after observing these plants for several years in their habitats, I have never found them growing intermingled, nor observed intermediate forms. *H. microphylla*, moreover, is extremely common, and variable in size, ranging as it does from a plant $\frac{1}{16}$in. to $\frac{5}{16}$in. in length; yet, however small the plant, it retains all the appearance of the larger ones. The fruitstalk, too, is always longer than the leaves. I may point out that *Hennedia* is in much the same position with regard to the leaves of its species as that occupied by *Dicranum* and *Campylopus*, in which the leaves of many species are almost identical. In conclusion, I may state that I have presented specimens of these species to the Christchurch Museum, so that any one interested in the matter can examine them.

DESCRIPTION OF PLATES XXXI. (in Part) TO XXXIII.

Plate XXXI. (in Part).

Hennedia macrophylla, sp. nov.

Fig. 1. Capsule and calyptra.
Fig. 2. Perichætial leaves.
Fig. 3. Stem leaves.

Plate XXXII.

Hennedia intermedia, sp. nov.

Fig. 1. Capsule and calyptra.
Fig. 2. Perichætial leaves.
Fig. 3. Stem leaves.

Plate XXXIII.

Hennedia microphylla, sp. nov.

Fig. 1. Capsule and calyptra.
Fig. 2. Perichætial leaves.
Fig. 3. Stem leaves.

Art. XXXV.—*Note on* Splachnidium rugosum, *Grev.*

By Robert M. Laing, B.Sc.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1892.*]

This interesting plant is a brown seaweed common on the coasts of both Islands, and growing a foot or two above low-water mark. It seems to be an annual, as specimens of it are very scarce during the winter months. It occurs at the Cape of Good Hope, and on the Australian coast, as well as in New Zealand. It was first described by Linnæus as *Ulva rugosa;* but the genus *Splachnidium* was afterwards founded for its reception by Greville, and it still remains the only species of the genus.

It has hitherto been included in the order *Fucaceæ*, because of its general external resemblance to them, and because it has conceptacles which were supposed to contain oogonia (*v.* "Phycologica Australica," plate xiv., Harvey). However, in May, 1890, I was examining some specimens of this plant which were lying in a saucer exposed to direct sunlight, when I noticed a number of what I took to be oospheres entangled amongst the hairs of a conceptacle near the top of the stem. I mounted them on a slide with sea-water, and burst them by a slight pressure. A large number of zoospores filled with colouring-matter were at once extruded, showing that the bodies in question were sporangia, and that previous observers had been wrong in imagining them to be oospheres. The zoospores were actively swimming in the water, and cilia were distinctly visible on many. Most were egg-shaped, a few were approximately circular, and an eye-spot was frequently discernible. On another slide I obtained some which had come to rest and thrown off their cilia—whether after conjugation or not I cannot say.

Since making these observations I have received a paper entitled, "On *Splachnidium rugosum*, the Type of a New Order of Algæ,"* by Margaret O. Mitchell and Frances G. Whitting, both of Newnham College. This contains an exhaustive description of the minute structure of the thallus and of the mode of growth; but the special feature of the paper is that the authors have arrived by indirect evidence at the conclusion that the bodies hitherto regarded as oogonia must be sporangia. Their examination of the plant shows that in its vegetative structure it is allied to some extent with the *Fucaceæ* (*e.g.*, in the possession of a conceptacle), but that on the other hand

* Dulau and Co., Soho Square, London; 1892.

in its reproduction it is connected with the *Laminariaceæ*. The sum of its characters, however, is such as to expressly exclude it from any existing natural order. They therefore propose to establish the order *Splachnidiaceæ* for its reception.

It must be very satisfactory to the authors of this excellent paper to find that the conclusion they have arrived at by theoretical considerations as to the reproduction of this plant is shown by observation to be justifiable and accurate. My own investigations, as far as they go, are quite in accord with theirs as to the minute structure of the thallus. Unfortunately, however, I have not been able as yet to examine the apical cell.

It may be worth mentioning that I have invariably found a particular diatom in the mucilage of this plant. It is spindle-shaped, and has a long elastic acicular process at each end. These processes are sometimes straight, sometimes curved or even hooked, and slightly clubbed. This diatom has been found in *Splachnidium* obtained near Wellington, and also in plants taken from Lyttelton Harbour. It may occasionally be found in the scrapings taken from the surface of the thallus. Those so obtained are more highly coloured with a characteristic brown pigment than those found in the interior, and appear (in some cases, at any rate) to escape through the ostiole. They may often be seen in slow motion, and are certainly worthy of further investigation.

ART. XXXVI.—*Description of New Species of Musci.*

By T. W. NAYLOR BECKETT, F.L.S.

[*Read before the Philosophical Institute of Canterbury, 5th October, 1892.*]

Plates XXXIV.-XLIV.

EARLY in the present year I sent a small collection of New Zealand mosses to Dr. Karl Müller, of Halle. He has very kindly examined them for me, and in a letter I lately received from him, giving me the results of his examination, he tells me that, of the seventy species sent, forty-eight are new. Some of these, I think, will prove to be but varieties of species already described. As Dr. Müller is unable to devote the time necessary to work out the new species, he has suggested that I should describe them, and publish them in the Transactions of the New Zealand Institute. He writes, "Should you make known in New Zealand the results of your collecting, and the mosses named by me, and should you feel disposed

to describe the new species, I very cordially agree with such a course." The names are those given by Dr. Karl Müller, but for any errors or inaccuracies in the descriptions I am alone responsible. In this paper I have described and figured a few of the most interesting of the new species, and I hope in a future paper to publish some more.

Blindia chrysea, sp. nov. Plate XXXIV.

Autoicous. Densely cæspitose in large tufts, erect, branched, golden-yellow above, dull olive-green below. Leaves densely imbricated, falcate, glossy, when dry the apices spirally twisted, oblong-lanceolate produced into a long narrow point, margin flat, quite entire; nerve green, thin, well defined, occupying the greater part of the subulate apex. Alar cells dark rufous-brown, large and inflated, cells of lower part of leaf long, narrow, becoming shorter and more quadrate towards the apex. Perichætial leaves, outer with a broad base suddenly contracted into a long narrow point, innermost lanceolate, amplexicaul, all nerved to apex. Seta thin, ferruginous, length ¼in.–1in. Capsule leptodermous, erect, symmetrical, oval, exannulate, ferruginous. Operculum and calyptra not seen. Peristome of 16 teeth, short, papillose, thin, indistinctly barred, the lower part yellow, hyaline above. Male inflorescence gemmaceous, axillary below the perichætial leaves, bracts concave, ovate - acuminate, antheridia long, mixed with numerous paraphyses.

Hab. On rocks. A very distinct and beautiful species, belonging to a genus not hitherto recorded in New Zealand.

Loc. Kaikoura; No. 263 (named by Dr. Müller). Benmore, 4,000ft.; No. 295. On the ground, Kowai; *T. W. N. B.* Mount Earnslaw; *W. Bell.*

Pottia marginata, sp. nov. Plate XXXV.

Synoicous. Cæspitose, minute, simple or dichotomous, olive-green, leaves, lower ovate-lanceolate, upper elongato-lingulate, acuminate, carinate, not narrowed below; nerve brown, stout, tapering at the apex and excurrent in a point; margin flat, bordered by four rows of long clear yellow cells, vanishing before reaching the apex, which is coarsely and irregularly dentate. Cells at the base and of one-third of leaf oblongo-hexagonal, hyaline, gradually merging into small, roundish, hexagonal, opaque, densely chlorophyllose cells. Seta stout, short; capsule gymnostomous, erect or slightly inclined, long-oval, gradually tapering into the seta, chestnut-brown, smooth, contracted at the mouth when dry; operculum conico-rostrate; calyptra covering the whole of the capsule, campanulate, base closely clasping the seta until near maturity, when

by the growth of the capsule it splits and becomes cucullate, cartilaginous, smooth. Inflorescence: ♂ and ♀ mixed together in the same inflorescence.

Hab. On clay banks.

Loc. Cachmere Road, Lyttelton Hills; October, 1887; No. 57. On dead "nigger-heads," Wairarapa Stream, Fendalton; July, 1889; *T. W. N. B.* Christchurch Domain Garden; *T. G. Wright.* Mungatui; September, 1887; *W. Bell.* Pine Hill, near Dunedin; January, 1890, No. 275 (named by Dr. Müller); *W. Bell.*

In an immature state the calyptra covers the entire capsule and tightly clasps the seta, as in the genus *Calymperes*, but on nearing maturity the growth of the fruit ruptures the very cartilaginous calyptra, when it becomes truly cucullate, and is pushed upward, covering only two-thirds of the capsule. The plant is therefore a true *Pottia.*

Orthotrichum graphiomitrium, sp. nov. Plate XXXVI.

Autoicous. Stems subrepent or laxly pulvinate; branches erect, 1in.–1¾in. long, more or less branched. Leaves laxly imbricated, patent, when dry appressed but not much altered; stem-leaves oblong-lanceolate, gradually acuminate, comal leaves larger, perichætial leaves longer and narrower than the comal ones. Nerve stout, carinate, vanishing within the apex; margins quite flat. Cells at the base long, yellow, above round, distinct, papillose. Capsule on a very short seta, hardly visible above the leaves, ovate, smooth, striæ very indistinct, narrowed gradually below. Stomata on lower part of capsule superficial, large. Operculum conic, rostellate, with a red line round the base. Calyptra conic, golden-yellow, darker at the apex and base, covered with long, jointed, pale-yellow hairs, plicate, base lobed. Peristome, outer of 8 teeth bigemmate, greyish-orange, obtuse, cilia 8, nearly as long as the outer teeth, broad, consisting of two rows of cells, pale-grey. Male inflorescence gemmiform, axillary in the lower leaves of fertile branches, bracts ovate-obtuse, nerved three-quarters, cells of lower half brown, antheridia about 12, paraphyses few or 0.

Hab. On the stems and branches of small trees at high elevations.

Loc. Arthur's Pass, 3,013ft.; No. 176 (named by Dr. Müller). On "ribbonwood" trees, Benmore; *T. W. N. B.*

This very handsome and distinct moss, often of a bright-golden colour, is extremely local, but very abundant in places where it is found. The subrepent mode of growth is unusual in *Orthotrichum.* It creeps along branches with quite the habit of *Macromitrium,* and forms patches 7in. or 8in. long.

Zygodon integrifolius, sp. nov. Plate XXXVII.

Autoicous. In soft, dense, green cushions, dark-brown below, sparingly branched. Leaves patent and recurved, curled and contorted when dry, linear, very acuminate, keeled; margins plane, quite entire, nerve stout, concolorous, vanishing within the apex. Cells at the base rectangular, not hyaline, gradually merging into minute, square, somewhat obscure cells. Perichætial leaves long, ovate, tapering gradually to a fine point, cells rectangular, uniform over the whole leaf. Seta short, curved. Capsule gymnostomous, just showing above the leaves, oval-pyriform, brown, marked with 8 darker striæ, when dry contracted below the mouth, grooved, urceolate. Operculum flat, with a blunt oblique beak. Calyptra small, cucullate, only covering the top of the capsule, fugaceous. Male inflorescence gemmaceous, axillary below the perichætial leaves, bracts 3–4 ovate-acuminate, nerved, antheridia few, paraphyses none.

Hab. In crevices and fissures of rocks in sheltered situations.

Loc. Benmore, Canterbury; alt., 4,000ft.; November, 1890; No. 297 (named by Dr. K. Müller). Thirteen-mile Bush; September, 1892. Studholme Bush, Waimate; April, 1892; *T. W. N. B.* Glenorchy, Lake Wakatipu; January, 1890; *W. Bell.*

Nearly allied to the European *Zygodon lapponicus*, B. and S.

Climacium novæ-seelandiæ, sp. nov. Plate XXXVIII.

Primary stem creeping, sending up erect dendroid stems, which are densely covered with matted roots and broad closely-appressed leaves. Branches generally simple, sometimes slightly pinnate, growing on all sides round the top of the stem, the lower branches longest. Leaves thickly inserted all round the branches, plicate, margins flat. Leaves of stem broad, cordate at base, the apex rounded, very concave, quite entire, nerved three-quarters of their length. Branch-leaves from a cordate base, broadly ovate, concave, tapering towards the apex, obtusely pointed, almost entire, nerve vanishing within the apex. Leaves towards the ends of the branches and of branchlets narrower ovate-lanceolate, apex obtuse and very coarsely toothed, nerve vanishing within the apex. Cells slightly enlarged at the basal angles; the cells at the base of the leaf bright yellow-brown; cells of leaf long, ends pointed. Fruit not seen.

Loc. Castle Hill, North Canterbury; *T. Kirk.*

This handsome moss has the habit and appearance of the European *Climacium dendroides.* The leaves are, however, different.

Andreæa cochlearifolia, sp. nov. Plate XXXIX.

Dioicous (?). In dense blackish-brown tufts. Stems 1½in. long, 1 line in diameter, sparingly branched, lower parts denuded. Leaves loosely imbricated, inflated, cochleariform, oval or ovate, margins flat in the upper half and not concave, entire, apex minutely apiculate, dull olive-green, nerve broad, vanishing about the middle of the leaf. Perichætial leaves long-ovate, convolute. Cells at the base long, yellow, rather opaque, forming a circular patch not extending to the margins; cells of leaf small, quadrate, becoming roundish towards the apex, not papillose. Capsule entirely exserted, cleft from base to apex into 4 or 6 valves, dark-purple male inflorescence, bracts 3, antheridia about 5, paraphyses 0.

Hab. Wet rocks, under dripping water.

Loc. Mount Bonpland; alt., 4,000ft.; Otago; No. 353; *W. Bell* (named by Dr. Müller).

Quite distinct from any hitherto-described New Zealand *Andreæa*, and growing in situations—in water—very unusual for species of this genus. The nerve is not of greater thickness than the leaf, and is composed of a number of rows (from 10 to 20) of long opaque cells, which branch off in a fan-shaped manner about the middle of the leaf, and are lost amongst the leaf-cells. The margin of the upper part of leaf is flattened out like the edge of a plate.

Andreæa pulvinata, sp. nov. Plate XL.

Dioicous. Densely pulvinate in large hemispherical masses, purplish-red, dichotomously branched. Stem 1¼in. to 1½in. long. Leaves distant, patent, small, ovate-lanceolate gradually tapering to a blunt point, nerveless; comal leaves larger, more or less falcato-secund; perichætial leaves large, broad, ovate, tapering to an obtuse point, convolute. Cells at the base, in the centre, but not extending to the margins, long, square-ended, of a rich orange-purple, leaf-cells regular, dot-like, and strongly papillose at the back. Male inflorescence in a round bud, bracts 3, very concave, orbicular, pointed, antheridia 2 or 3, paraphyses none.

Hab. On south-east faces of rocks.

Loc. Rockwood, North Canterbury; November, 1890; No. 359 (named by Dr. Müller).

A very distinct species. The male plant shows the inflorescence of past years like beads upon a string. The inflorescence is truly terminal, though apparently lateral through being pushed aside by the new shoot which is developed immediately below the bracts.

Andreæa arctoæoides, sp. nov. Plate XLI.

Dioicous. In fragile dark-green or brownish tufts. Stems 4 to 9 lines long, simple or fastigate. Leaves spreading,

crowded, orange-yellow, apices darker, appressed when dry, oval, suddenly attenuated and tapering into a long point, which is sometimes slightly falcate; nerve indistinct, darker coloured, vanishing in the narrowed part; perichætial leaves 3 or 4, large oval, suddenly contracted into a narrow point one-third the length of the whole leaf, faintly nerved half-way; cells of centre of the leaf at base and on each side of nerve long and narrow, leaf-cells oval, small. Capsule 4-valved, oval, not exserted beyond the apex of leaves. Male inflorescence—bracts ovate, narrowed into a small point, antheridia few, paraphyses numerous, long, thin, smooth, the joints very inconspicuous, dark-orange.

Hab. On rocks.

Loc. Rockwood, North Canterbury; November, 1890; No. 371 (named by Dr. Müller). Mount Torlesse; April, 1892; No. 412; *T. W. N. B.*

Quite distinct from *A. pulvinata* in its mode of growth and form of leaves.

Hypnum (Heterophyllum) kirkii, sp. nov. Plate XLII.

Minute, growing in dense close cushions, stems irregularly branched. Leaves greyish-green, not much altered when dry, linear, lanceolate, gradually attenuated from the base to a slender point, apex minutely serrated, nerveless, base of leaf concave, with flat hyaline alæ with large hyaline cells, cells at centre of base distinct bright yellow, cells of leaf long, distinct, slightly sygmoid; perichætial leaves much larger, erect, outer ovate-acuminate entire, inner ovate-lanceolate gradually tapering to a fine point very slightly denticulate at the apex, lower half of all bright yellow. Seta smooth, 5 lines long, brownish-red, vaginula large, turbinate. Capsule slightly inclined, oval. Operculum conic, with a long attenuated beak. Peristome, teeth pale yellow, lanceolate, subulate, inner surface very trabeculate, endostome consisting of 16 carinate imperforate processes without intermediate cilia.

Hab. Growing on trees and decayed bark.

Loc. The Snares; No. 370; *T. Kirk;* 1890 (named by Dr. Müller). Paterson's Inlet, Stewart Island; *T. Kirk;* 1890.

Fissidens (Heterocaulon) ramiger, sp. nov. Plate XLIII.

Rhizantoicous, solitary or gregarious, minute. Fertile stems very short; leaves few, two inner ones convolute round the seta, apex produced into a long point; lower ones (2 or 3) smaller, diminishing in size; the vaginant laminæ occupying nearly the whole of the leaf, the superior lamina very short and narrow, and curved into a beak. Barren stems—leaves 8–10-jugous, lower smaller shorter and ovate, ovate-lanceolate

towards the upper part of stem; vaginant laminæ two-thirds the length of leaf; inferior lamina narrow, vanishing before the base, nerve thick, vanishing in the apex, immarginate, entire. Cells large, irregular, hexagonal. Seta short, stout, yellow, three times the length of capsule. Vaginula very wide. Capsule oval, symmetrical, erect or very nearly so. Operculum not quite half the length of capsule, conic, apiculate. Peristome red, teeth cleft to the middle into two long filiform legs, undivided part strongly trabeculate. Male inflorescence gemmiform, situated at the base of the fertile stems, amongst the roots.

Hab. On clay.

Loc. Lyttelton Hills; No. 376 (named by Dr. Müller). On sod-banks, Malvern Hills; September, 1892.

In some specimens the margin of the vaginant laminæ has a slight border of long cells. In several instances I have observed twin setæ in one inflorescence.

Fissidens (Bryoidium) campyloneurus, sp. nov. Plate XLIV.

Dioicous(?). Densely gregarious. Very small, simple, leaves pale yellowish-green, crisped when dry, lanceolate, very acute, vaginant laminæ half the length of leaf, inferior lamina narrowed below and vanishing towards the base; nerve stout, with a considerable bend where it passes below the vaginant laminæ, which it encircles on the inner side, continued to the apex, where it unites with the border, which is continuous round the whole of the leaf; border composed of two or more rows of long paler cells; leaf-cells rounded-hexagonal, distinct. Barren shoot 7–9-jugous. Fertile stems, 3–plurijugous, procumbent, causing the erect seta to have a bend close to the vaginula; leaves linear-lanceolate, longer and narrower than on the barren shoots, the two perichætial leaves longest. Seta pale-red, slender, flexuous. Capsule short, oval, erect or slightly inclined, contracted below the mouth when dry. Operculum conic, with a straight blunt beak. Peristome deep brownish-red, not inserted below the mouth, teeth cleft two-thirds into two slender legs, the lower undivided portion closely and strongly trabeculate, the bars on the legs placed diagonally, giving them a spirally-twisted appearance.

Hab. On damp clay.

Loc. Waimate, South Canterbury; No. 150 (named by Dr. Müller). Mount Fife, Kaikoura; No. 267. Benmore; alt., 4,000ft. Patterson's Creek, Mount Torlesse; *T. W. N. B.* Pine Hill, Dunedin; *W. Bell.*

In the apical leaves of barren plants the border and nerve vanish towards the apex, though in the lower leaves

on the same branch they are well defined to the extreme point. Resembling *F. viridulus*, Wähleub, from which it is distinguished by the peristome, which in *viridulus* arises from below the mouth of the capsule. The peculiar twist in the nerve, which is a very constant character, also separates the two species.

EXPLANATION OF PLATES XXXIV.-XLIV.

Plate XXXIV.—*Blindia chrysea.*

Fig. 1. Plant, natural size.
„ 2. Leaf, × 32.
„ 3. Cells near base, × 270.
„ 4. Cells from centre of leaf, × 270.
„ 5. Cells from apex, × 270.
Fig. 6. Perichætial leaf, × 32.
„ 7. Ripe capsule, × 37.
„ 8. Peristome, × 270.
„ 9. Male inflorescence, × 32.
„ 10. Antheridia and paraphyses, × 70.

Plate XXXV.—*Pottia marginata.*

Fig. 1. Plant, natural size.
„ 2. Leaf, × 32.
„ 3. Marginal cells, × 270.
„ 4. Apex of leaf, × 270.
„ 5. Cells from base of leaf, × 270.
„ 6. Cells, transitional from hyaline to chlorophyllose, × 270.
Fig. 7. Immature capsule, showing the calyptra covering the whole fruit and clasping the seta, × 12.
„ 8. Ripe capsule with calyptra, × 32.
„ 9. Operculum, × 32.

Plate XXXVI.—*Orthotrichum graphiomitrium.*

Fig. 1. Stem-leaf in profile, × 32.
„ 2. Comal leaf, × 32.
„ 3. Apex of leaf, × 70.
„ 4. Cells at base, × 270.
„ 5. Leaf-cells, × 270.
„ 6. Capsule, × 12.
Fig. 7. Calyptra, × 12.
„ 8. Base of calyptra, × 70.
„ 9. Stomata, × 270.
„ 10. Peristome, × 70.
„ 11. Operculum, × 32.
„ 12. Male inflorescence, × 32.

Plate XXXVII.—*Zygodon integrifolius.*

Fig. 1. Plant, natural size.
„ 2. Leaf, × 32.
„ 3. Apex of leaf, × 270.
„ 4. Basal cells, × 270.
„ 5. Leaf-cells, × 270.
„ 6. Perichætial leaf, × 32.
Fig. 7. Capsule, × 32.
„ 8. Old and dry capsule, × 32.
„ 9. Operculum, × 32.
„ 10. Male inflorescence, × 70.
„ 11. Bract and antheridia, × 70.

Plate XXXVIII.—*Climacium novæ-seelandiæ.*

Fig. 1. Plant, natural size.
„ 2. Stem-leaf, × 32.
„ 3. Leaf from main branches, × 32.
Fig. 4. Alar cells, × 270.
„ 5. Leaf-cells, × 270.
„ 6. Leaf from branchlet, × 32.
„ 7. Apex of same, × 70.

Plate XXXIX.—*Andreæa cochlearifolia.*

Fig. 1. Plant, natural size.
„ 2. Comal leaf, × 32.
„ 3. Stem-leaf, × 32.
„ 4. Apex of leaf, × 70.
„ 5. Cells at apex of leaf, × 270.
Fig. 6. Leaf-cells, × 270.
„ 7. Capsule, × 12.
„ 8. Male bract and antheridia, × 70.

PLATE XL.—*Andreæa pulvinata.*

Fig. 1. Plants, natural size.
„ 2. Leaves, × 32.
„ 3. Comal leaf, × 32.
„ 4. Perichætial leaf, × 32.
„ 5. Cells from base of leaf, 270.
Fig. 6. Leaf-cells, × 270.
„ 7. Papillæ from back of leaf, × 270.
„ 8. Male inflorescence, × 70.
„ 9. Bract and antheridia, × 70.

PLATE XLI.—*Andreæa arctoæoides.*

Fig. 1. Plants, natural size.
„ 2. Leaves, × 32.
„ 3. Perichætial leaf, × 32.
„ 4. Part of nerve and adjacent cells, × 270.
Fig. 5. Leaf-cells, × 270.
„ 6. Male bract, × 32.
„ 7. Paraphyses, × 270.

PLATE XLII.—*Hypnum kirkii.*

Fig. 1. Plant, natural size.
„ 2. Leaf, × 32.
„ 3. Leaves, × 70.
„ 4. Apex of leaf, × 270.
„ 5. Base of leaf, × 270.
„ 6. Outer perichætial leaves, × 32.
Fig. 7. Capsule and operculum, × 32.
„ 8. Vaginula, × 32.
„ 9. Peristome, × 70.
„ 10. Endostome, × 70.

PLATE XLIII.—*Fissidens ramiger.*

Fig. 1. Plants, natural size.
„ 2. Barren plant, × 32.
„ 3. Fertile plant, × 32.
„ 4. Male inflorescence, × 32.
„ 5. Perichætial leaf, × 32.
Fig. 6. Leaf, × 32.
„ 7. Apex of leaf, × 270.
„ 8. Leaf, × 70.
„ 9 and 10. Capsule and operculum, × 32.

PLATE XLIV.—*Fissidens campyloneurus.*

Fig. 1. Plants, natural size.
„ 2. Leaves, × 32.
„ 3. Apex, × 270.
„ 4. Perichætial leaf, × 32.
„ 5. Leaf from middle of barren stem, × 270.
Fig. 6. Leaf from apex of the same stem, × 270.
„ 7, 8, 9. Capsules, × 32.
„ 10. Tooth of peristome, × 270.

ART. XXXVII.—*On some Little-known New Zealand Mosses.*

By T. W. NAYLOR BECKETT, F.L.S.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1892.*]

SINCE the publication of the "Handbook of the New Zealand Flora" in 1867 many additions have been made to our moss-flora; and it is the object of this paper to put on record as having been found in New Zealand species which have already been published from other countries.

In 1889 Mr. William Bell, of Pine Hill, Dunedin, sent a collection of mosses, chiefly belonging to the family *Orthotricheæ*, to Mr. Mitten for identification. Mr. Bell has kindly placed Mr. Mitten's letter and notes at my disposal, and supplied me with type specimens of the mosses. Mr. T. Kirk has lately allowed me to examine an interesting collection of seventy-nine Westland mosses, made by Mr. R. Helms, of Greymouth, in 1882. They were sent that year to Dr. Karl Müller for determination, and he decided that thirty-six were new to science. These he has named; but he tells me, in a letter which I have recently received from him, that they have not yet been described, and have not been published.

With the material these collections afforded me, and a few mosses derived from other sources, I am enabled to enumerate fourteen mosses not hitherto included in the New Zealand flora.

Blindia robusta, Hampe.

"Cæspitosa, robusta, sesquiuncialis parce ramosa, folia maxime falcata integerrima, nervo plano evanescente, cellulis linearibus versus apicem densioribus flavescentibus, echlorophyllosis, alaribus grandibus subquadratis hyalinis; seta crassa semiuncialis flavescens, theca subrotundo-ovalis, coriacea fusco-rubra suberecta, operculo conico-obliquo crasso subulato thecam dimidiam æquante pallidiore, dentibus peristomii latioribus membranaceis inflexis plus minusve regulariter divisis. *Hab.* In Alpibus Austr., Mount Munyang."—"Linnæa," 1859–60, p. 627. F. von Müller's "Analytical Drawings of Australian Mosses," tab. 7.

Autoicous. Male inflorescence bud-like, terminal in a branch below the female inflorescence, bracts obovate abruptly contracted into a lanceolate point, antheridia numerous (23).

Hab. On old moraine at the base of the Waimakariri Glacier; 1889; *R. Brown.*

I have authentic specimens of *B. robusta* from Mr. Sullivan, collected in snowy watercourses, Mount Kosciusko, New South Wales, which enabled me to identify this moss.

Grimmia leucophæa, Greville, in Trans. Werner Soc., iv., f. 6.
Grimmia leiocarpa, Taylor.

Readily known from the other New Zealand species of *Grimmia* by its very rough hair-points. A cosmopolitan species.

Hab. On boulders, Dyer's Pass, Lyttelton Hills; No. 114; 1888; *T. W. N. B.* Banks of the Clutha, Otago; 1891; *W. Bell.*

I have this moss also from the Barossa Range, South Australia, *Tepper;* and from Queensland, *Bailey.*

Anomodon huttonii, Mitten.

"Caulis procumbens, ramis ascendentibus subpinnatim divisus; folia caulina patentia, ovata, acumine lato apice acutiusculo, nervo indistincto supra medium evanido, ramea subcompressa, basi subovata, ligulata, acutiuscula, omnia inferne canaliculato-concava, apicem versus plana, cellulis rotundis obscuris papillosis, margineque crenulata. *Hab.* New Zealand, Great Barrier Island; *Hutton et Kirk.*"—Mitten, Journ. Linn. Soc., vol. xiii., p. 309.

As Mr. Mitten's description of this interesting moss was published in his paper on Ceylon *Musci*, and may be overlooked, I reproduce it here.

The branches are extremely filiform, 4–6 lines long; when dry julaceous and not more than $\frac{8}{1000}$in. in diameter, with the leaves closely appressed. When moist the leaves are patent. The cells are large, roundish-hexagonal, and very uniform in size over the whole of the leaf. There are a few long cells on each side of the nerve at its base. The nerve, from a broad base, tapers, and vanishes above the middle of the leaf. Each individual cell projects at the edge of the leaf, causing the margin to be minutely crenulate.

Mr. Kirk, to whom I am indebted for this moss, informs me that he found it but sparingly on the Great Barrier, but freely at Omaha and Matakana, and other places in Auckland.

In "Herb. Bell," identified by Mr. William Mitten.

Tortula muralis, Hedwig.

A very cosmopolitan plant, but not before recorded as found in Australasia. On chimney, Pine Hill, near Dunedin; *W. Bell;* No. 649.

Orthotrichum rupestre, Schleich.

On rocks, Mount Earnslaw; 1890; *W. Bell.* Mount Benger, 4,000ft.–5,000ft., and Pine Hill; *W. Bell;* No. 265; 1887. Mount Fife, Kaikoura; *T. Kirk;* 1889. Benmore, alt. 4,000ft.; *T. W. N. B.;* 1890.

Orthotrichum tasmanicum, H. f. and W. (London Journ. Bot., vii., 1848, p. 27.) Flora Tasm., ii., 184.

On twigs of bushes (especially *Discaria toumatou*); not uncommon. Lake Wakatipu and Pine Hill; *W. Bell;* Nos. 438, 646; 1888. Mount Torlesse, 1892; Hunter's Hills, Waimate; Little River, Akaroa, 1887; *T. W. N. B.*

Zygodon minutus, Hampe and C. Müll. ("Linnæa," 1856, p. 209). Flora Tasm., ii., 186.

Found in Australia and Tasmania. Paterson's Inlet, Stewart Island; *W. Bell;* No. 674*a*; 1889. On the bark of ngaio trees (*Myoporum lætum*), Maungamana Bay, Kaikoura; 1889; *T. W. N. B.*

Eucamptodon inflatus, Mitten. *Hypnum inflatum*, H. f. and W. Fl. N.Z., ii., tab. 90, fig. 5.

"I send a stem of the *Hypnum inflatum* of Fl. N.Z. No fruit has been seen. I keep it as a species of *Eucamptodon* which is almost the same as *Dicnemon:* but *Eucamptodon* has an erect capsule; in the other genera it is curved and unequal. These are dicranoid mosses, having no affinity with *Hypna* of any kind. *Eucamptodon inflatus* is the finest species yet discovered. In both genera, *Dicnemon* and *Eucamptodon*, the primary stem is creeping, from which fertile branches arise."—W. Mitten in litt.

Great Barrier Island; *T. Kirk.* Near Auckland; *T. F. Cheeseman.*

In "Herb. Helms," identified by Dr. Karl Müller.

Hypnum (Hypnodendron) deflexum, Wilson.

This is *Isothecium arbusculum*, var. *β deflexum*, Fl. N.Z., ii., 104; *Hypnum deflexum*, C. Müll., Syn. ii., p. 680. Mr. Mitten considers this moss distinct from *Isothecium arbusculum*, "Australian Mosses," p. 35.

Found in New South Wales and Tasmania. "Herb. Helms," No. 3.

Hypnum (Rhynchostegium) huttoni, Hampe.

Nearly allied to *Rhynchostegium tenuifolium*, Hed. Autoicous, male inflorescence bud-like in the axils of leaves below the female inflorescence.

Westland, "Herb. Helms," No. 16. Pine Hill, Dunedin; *W. Bell;* No. 657; 1888. Greymouth; *W. J. Gulliver.* Barry's Pass, Akaroa; *T. W. N. B.;* No. 55; 1887.

Pilotrichella billardieri, Hampe ("Linnæa," 1859, *Neckera*).

Meteorium billardieri, Mitten, "Australian Mosses," p. 34.

Found in Gippsland: *F. v. M.* It very much resembles a large form of *M. molle.* "Herb. Helms," No. 41. Kaikoura, No. 13*b*, identified for me by Dr. Müller. Oxford Bush, North Canterbury; *T. W. N. B.* Nelson; *D. Grant.*

Rhizogonium aristatum, Hampe.

"Gracillimum, laxe cæspitosum, unciale, adscendens. Caulis filiformis basi nudus vel foliis parvis remotis ovatis cuspidatis munitus, superne foliis approxumatis, anguste plumiformis flavescens. Folia disticha, oblique inserta, uno latere patenti concava, e basi parce obovata late lanceolata, planiuscula, margine flavescenti limbata, versus apicem remote dentata, nervo lutescente solido aristata, cellulis angulato-rotundatis parce incrassatis, pallide diaphanis. Folia perichætialia lanceolato-subulata elongata subintegerrima vel parce denticulata erecta, apice pallida, nervo percursa longius aristata. Seta basilaris erecta sesquiuncialis caulem superans, apice incrassata rubra. Theca læsa horizontalis oblonga annulata peristomio? Lake Pedder, Tasmaniæ; parcissime legit *Schuster*. *Rhizogonio novæ-hollandiæ* simillimum, sed foliis limbatis primo visu discernendum."—"Linnæa," xl., 1876, p. 314.

Greymouth, in "Herb. Helms," No. 49. Westland; *T. Kirk*. Stewart Island, on stems of tree-ferns; *W. Bell*; No. 715.

Dicranum (Campylopus) capillatus, H. f. and W. Flora Tasm., ii., 172.

A Tasmanian moss nearly allied to *Campylopus appressifolius*. Westland, in "Herb. Helms," No. 64.

Dicranum (Campylopus) leptocephalum, C. Müll. ("Linnæa," 1855, p. 206).

Mitten, in "Musci Austro-Americani," Jour. Lin. Soc., xii., p. 84, gives this as a synonym of *Campylopus introflexus*, Hed., and remarks, "*C. introflexus* is very variable in external appearance—in the colour of the leaves, and in the length and curvature of their white points." "Herb. Helms," No. 73.

Bartramia commutata, Hampe.

"Dioica, robusta, vage ramosa, decumbens. Caulis fere ubique rufo-tomentosus, fructifer adscendens, superne radiatus, flavescens, ramis teretibus acutis, caulis masculus subsimplex, apice stellatus. Folia caulina sicca accumbentia humido erecto-patula, e basi contracta concava pluries plicata, late ovato-lanceolata subintegerrima, nervo percursa setaceo-aristata, margine toto revoluto, cellulis abbreviato-parallelogrammicis, nodulis minimis interrupto-punctatis, basi latere velo tenero latiore reflexo, cellulis quadratis reticulato pellucido aucta. Radiorum folia minora, magis pellucida, tenerrime reticulata, evidenter scabra, nervo tereti lutescente in subulam

denticulatam excedente. Folia perichætialia interiora parva, ovato-lanceolata nervosa, brevius aristata, profunde plicata, hyalina, cellulis rectangulis lævibus reticulata. Seta vix uncialis adscendens rubens apice inclinata. Theca junior sphærica, deinde nutans, oblonga, sicca paulisper striata; operculo breve conico obtuso. Peristomium inflexum parvulum sanguineum, dentibus exter. anguste lanceolatis acuminatis dense trabeculatis; intern. cruribus ovato-acuminatis, ciliis brevissimis.

"Mount Grampians; leg. *W. Sullivan.*

"Syn. *Bartramia affinis*, Schwæg., tab. 237, mala; nec Hooker, tab. 176. In Tasmania, in montosis versus lacum Pedder, 1875, legit Schuster formam minorem vix biuncialem."—"Linnæa," 1876, p. 307.

Nearly allied to *B. affinis.* Mitten, in "Australian Mosses," p. 21, considers it a distinct species. Westland, in "Herb. Helms," No. 68.

Art. XXXVIII.—*On a New Insectivorous Plant in New Zealand.*

By Sir Walter L. Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 7th December, 1892.*]

As is probably well known to all present, we possess in New Zealand several species of *Drosera*, a group of plants which not only catch insects by means of their tentacles and the viscid matter secreted from their glands, but which, as Darwin has conclusively shown, have likewise the power of dissolving animal matter by the aid of this secretion, which contains an acid, together with a ferment almost identical in nature with pepsin, the matter thus digested being afterwards absorbed into the system of the plant as a means of nourishment. Darwin has fully described other insect-catching plants—*Drosophyllum*, *Roridula*, and *Byblis* effecting the capture by means of their viscid secretion alone, and *Dionæa* and *Aldrovanda* through the rapid closing of their leaves. All these carnivorous plants belong to a recognised family known as the *Droseraceæ*, comprising six well-determined genera.

The New Zealand plant which I desire to bring under your notice to-night is something entirely different. It is a species of fungus belonging to the genus *Aseroe*, described thus in Hooker's Handbook (vol. ii., p. 616): "A curious genus, the arms of whose pileus somewhat resemble a starfish. Found in New Zealand, Ceylon, and Australia. Volva globose, gela-

tinous within; pileus stalked, divided at the summit into long radiating simple entire or forked horizontal arms; hymenium at the base of the arms." The species to which I am about to refer is thus described by the same distinguished botanist:—

"*Aseroe rubra*, Labill., Fl. N. Holl., ii.; Berk., in Fl. N.Z., ii., 187. Two to four inches high; stem as thick as the thumb, even. Rays of the pileus about 8, bright-red, long, subulate, 1in.–2in. long, split to the base, continuous with the stem, not divided from them by a deep groove."

Another species of the same genus, discovered by Mr. Colenso at the Bay of Islands, has been described, and named *Aseroe hookeri;* but I have never seen it.

There is an excellent coloured drawing of *Aseroe rubra* in the appendix to the Rev. Richard Taylor's "New Zealand and its Inhabitants" (pl. v., fig. 3).

I have met with this plant in various parts of New Zealand, always in the depth of the woods, its star-like form and bright colour attracting immediate notice. But what I desire to call attention to now is the singular fact (hitherto unrecorded) that this fungus appears to be insectivorous in its habit of life. Its presence is always indicated by a peculiar fœtid smell, like decomposing animal matter, and so pungent in its nature that on handling the plant this very disagreeable odour communicates itself to the fingers, and can only be got rid of by washing the hands in water.

On a recent occasion I found several of them growing in the woods near the Papaitonga Lake; and Mr. Morgan Carkeek, the District Surveyor, who happened to be with me at the time, drew my attention to the fact that each of them had the surface-cup, if I may so term it, completely filled up with the partially-dissolved bodies of dead insects. Mr. Carkeek assured me that during the many years he has spent in the New Zealand forests he has invariably found this plant garnished in a similar manner.

From the interior of the stem a viscid foul-smelling fluid is secreted, and this rises into the cup and mixes with the bodies of moths, flies, beetles, and other small insects collected there, which appear to undergo a process of gradual dissolution and absorption. Now, the question arises, Is this fungus, like the *Drosera*, a carnivorous plant, and is it endowed with its pungent odour, added to its flower-like brilliancy, for the purpose of attracting its insect-food? And is the fluid itself a solvent, with the acid constituent for aiding the process of digestion? My answer is in the affirmative.

I dissected one of the stems, and found that it was hollow, or nearly so, with what appeared to be a membranous sac at the bottom containing fluid matter; but the examination,

made on the spot, was necessarily a very hasty and imperfect one.

Since the above was written I have received a letter from Mr. J. Brough, of Nelson (a very observant settler), forwarding me a pressed specimen of the star-like portion of the plant, which I now exhibit, and accompanied by the following note:—

"I wish to bring under your notice a rare fungus I met with some time ago in the locality of Rotoiti Lake. I have never noticed anything of the kind in my travels before. There were six of them, forming a sort of circle. They had the appearance when growing of a flesh-and-blood colour, and several insects and spiders were sticking about each of them. I preserved three of them, and I send you one herewith. Of course it is now dried up, and you merely get the outline, but no doubt this will be sufficient to enable you to send me its botanical name."

Art. XXXIX.—*Botanical Notes from Takaka District.*

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 28th March, 1892.*]

The ferns which I exhibit this evening are a portion of those I collected during a recent trip to the Takaka district in company with Mr. W. H. Bryant, of Brightwater.

We carried our tents and provisions ourselves without the aid of a horse, and could therefore stop where and when we chose. For real enjoyment and effective work this method, although somewhat laborious, has many advantages over the customary trap or pack-horse.

On our trip we touched at the Tata Islands, and walked from Waitapu by Rangihaeata Point and Anahau to Puramahoi, thence back to Motupipi, thence up the Takaka Valley over the range to Motueka.

The following are the most rare specimens collected or noted on the trip:—

Schizea bifida. Between Takaka and Puramahoi. This has not been hitherto recorded as found in this part of New Zealand.

S. fistulosa. Very plentiful near Takaka.

Lycopodium laterale. Near Takaka; not very common.

Hymenophyllum tunbridgense. Fine examples on Takaka Ranges.

H. tunbridgense, var. *unilaterale.* Also on Takaka Ranges.

H. malingii. This beautiful fern is fairly plentiful on the top of the range.

H. rufescens. Also growing on the top of the range.

H. demissum and *subtilissimum.* Of these, exceedingly large and fine specimens were collected.

Trichomanes strictum and *rigidum.* Both forms were growing luxuriantly near Puramahoi; so also was

T. colensoi, near the same locality.

Cystopteris fragilis. Good specimens of this beautiful fern were obtained on the limestone, Takaka Ranges.

Lindsaya linearis, trichomanoides var. *lessoni, Pteris scaberula, tremula, incisa,* and *macilenta,* were also fairly plentiful.

Lomaria nigra and *fraseri.* Some remarkably fine specimens were collected at Puramahoi.

Gleichenia flabellata. Growing near Takaka. This is quite new to this Island.

Asplenium trichomanes, obtusatum var. *lyalli,* and *umbrosum.* Also noticed the latter abundant in Takaka Valley.

Todea superba and *Botrychium ternatum.* Very fine specimens of both between Takaka and Riwaka.

Lycopodium billardieri between 5ft. and 6ft. long, and *Tmesipteris forsteri* over 4ft. long, were collected, and I now exhibit specimens.

Mr. Bryant also found *Senecio laxifolia* and *Arthropodium cirrhatum* in flower, although so late in the season.

In conclusion, I should like to add that the district appears to be a perfect paradise for a botanist. The people are kind and hospitable, and the weather we experienced was almost perfect. The bush scenery is quite charming—that is, where the axe of the settler has not yet destroyed it, or the fire-loving vandals of these colonies have not desecrated it. One thing afforded great pleasure, and that was the presence of many little native birds; whereas in the neighbourhood of Nelson one rarely sees any, in consequence of the supineness of the authorities to the wilful destruction by guns and catapults in the hands of boys, who at every opportunity sally forth to gratify their bloodthirsty proclivities by taking the lives of those confiding insectivorous birds, designed by Nature to restrain the increase of insect pests. The destruction of these birds in the near future, I am convinced, will be looked upon as an irreparable calamity.

Art. XL.—*On a Remarkable Variation in* Lomaria lanceolata.

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 28th March, 1892.*]

The plant which forms the subject of this short paper (and of which I exhibit specimens) was collected by Mr. W. H. Bryant and myself on the north-western slope of "Little Ben," a hill whose altitude is about 2,884ft., and situate some seven or eight miles up the Wairoa River.

Our visit was a very short one. We ascended the hill on the morning of the 1st January last, and stayed one night only, and this short stay was further limited by rain on the forenoon of the 1st. Nevertheless we saw much of interest, and the trip was thoroughly enjoyable.

In a well-wooded gully we found a number of plants of *Lomaria lanceolata*, and in one spot, for a distance of about three or four yards, we found the greater portion of them showing a tendency to vary: some showed a bifurcate tendency, others trifurcate, and in two cases a quadrifurcate variation. We did not in any plant find every frond furcated, but in one specimen I noticed eight fronds, both fertile and sterile, which had varied in one direction or another.

It was curious to notice that nowhere else could we discover any tendency to vary, although this species of *Lomaria* was abundant.

I communicated the fact to Mr. Kirk, and furnished him with specimens, and he informs me that he has no previous record of a tendency to vary in *Lomaria lanceolata*.

Mr. W. H. Bryant is attempting to propagate this variety from the spores.

In the Wairoa Valley I also noticed a remarkable case of reversion in *Pseudopanax ferox*. At about 12ft. from the ground, in a tree whose diameter was over a foot, there is a tuft of those peculiar and strikingly ornamental leaves of the young-plant type.

On the side of Little Ben I gathered a specimen of fungus which Mr. Kirk tells me is new to New Zealand flora, and has no near-allied species.

The new *Asplenium*, *A. tenuifolium*, is also found growing in the Wairoa Gorge. It was originally discovered at Takaka (*vide* Trans. N.Z. Inst., vol. xxiii., p. 424).

Some very large manuka trees were also observed on Little Ben, from 2ft. to 3ft. in diameter, the finest I ever saw. I do not know if this is an unusual size.

ART. XLI.—*Bush Jottings: No. 2 (Botanical).*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th September, 1892.*]

> The harvest of a quiet eye,
> That broods and sleeps on his own heart.
> WORDSWORTH.

HAVING been called on by our Honorary Secretary to furnish a paper (or a "forfeit"*) for our branch Institute for this session of 1892, and having again spent a large portion of this year in this high inland wooded district (commonly called "the bush"), I think I cannot do better than to jot down a few of the more interesting botanical sights I have witnessed with more or less of delight, especially when considered in connection with the many pleasurable feelings they evoked. And these I would divide into three groups,—

I. Curious, scarce, and unique.
II. Peculiar and pleasing.
III. Striking, though common.

I. CURIOUS, SCARCE, AND UNIQUE.

1. And first of a fern, *Polypodium pennigerum*, Forst. While walking in a wood near Dannevirke, I was suddenly surprised on noticing a tall subarborescent fern of this species; its main caudex or stem was about 12in. high, rather slender, with six regular branch-stems (one of them being forked) issuing from around it, each about 1ft. long, and all upright, presenting a neat candelabrum-like appearance. Unfortunately the upper leafy portions of their fronds had been either cut off or eaten by cattle, leaving only their stems (stipites). These, with the branches and upper part of the main stem, were all lately dead, but the plant was springing vigorously afresh from near its base. Very likely, had the plant been uninjured and flourishing, with its large and numerous leafy and drooping fronds (in its usual state), I should not have seen its peculiar manner of growth, as it grew in a flat part of the forest. I had not unfrequently noticed this fern, when growing undisturbed on low alluvial ground by the sides of streams, to possess a short coalescent trunk of a foot or more long, but never before saw one branched; and so I thought it worthy of being recorded.

* This refers to a sentence in my Presidential Address of 1888—viz., "that every member should contribute annually at least one original paper, or five good specimens to the Museum, or two suitable books to the Library" (p. 19).

2. Of an orchid, *Gastrodia leucopetala*, Col. In another part of the same wood I was much pleased on finding no less than eleven specimens of this (now rare) terrestrial orchid, all growing together within a small semi-enclosed spot of about 2ft. in diameter; and just beyond were two more. This was at the end of January, and of course they were all past flowering, as this curious plant flowers about Christmas; their upright reed-like stems were nearly alike in size, each being about 2½ft. high, and full-flowered. The eleven specimens were growing close to the base of a large living rimu tree (*Dacrydium cupressinum*), and nearly surrounded by its high and naked roots, projecting like ridges from its trunk, which no doubt had been the means of preserving the roots of these plants, which are tolerably large and fleshy, and are edible both by man (the old Maoris) and pigs. In fact, I have long been of opinion that the main cause of this orchid now being so rarely met with in its forest habitat is owing to its root being eagerly sought after and eaten by the wild pigs. For a full description of this fine species see Transactions N.Z. Institute, vol. xviii., p. 268. I may further remark that those specimens there described were also obtained from another part of this same wood.

While mentioning a species of the order *Orchideæ*, I may further observe that several of the indigenous epiphytal ones are well represented in the forests here—viz., *Dendrobium lessonii*, Col.; *Earina autumnalis*, Hook.; *E. mucronata*, Lindl.; *E. quadrilobata*, Col.; *E. alba*, Col.; also, but more sparingly, that curious and rare one *Sarcochilus breviscapa*, Col.: all these usually grow high up on the larger timber-trees, in the forks of their main upper branches, which makes it to be so difficult to get good specimens of them; but now that those trees are being felled for timber, specimens of those orchids are more easily obtainable.

These plants certainly add largely to the beauty of our New Zealand forests in their flowering-season, about midsummer, when gracefully pendent producing their numerous flowers at the tips of their long lithe branchlets swinging in the wind. Indeed, the curiously-marked long woody polished ringed stems of the *Dendrobium* are a pleasant object of contemplation and study, as such are sure to remind the beholder of the regularly-ringed and shining stems of the malacca and other walking-canes.

3. A fungus, *Ileodictyon cibarium*, Tulasne, var. *giganteum*, Col. Of this highly-curious fungus I have met with a remarkable fine specimen, which I have (for the present) termed a *variety*, but which may prove to be another species of that strange and singular genus. It is not only twice or three times the size of the largest I have ever yet seen, but it

has other peculiarities. Unfortunately, the description of *I. cibarium* in Hooker's "Flora of New Zealand" is very insufficient. This species is pure-white, of an oblong shape, somewhat resembling that of a large inflated bladder of open network, being 14in. long and 9in. wide, possessing twenty-two large pentangular irregular-size meshes, the largest being about 4in. by 2in.; their ribs very wide, 6–8 lines, and much corrugated and pitted, with peculiar triangular holes in the middle of the rib at each outer angle: its volva, originally before bursting about the size of a pigeon's egg, is thickish, gelatinous, and strongly marked internally with white cross-lines corresponding with the more prominent net-like ribs of the pileus when closely compressed within.

But its curious history has yet to be told. It was late in the autumn (May), when I was in a grassy spot on the confines of a small retired wood (whither I had often been in former years), when on seating myself on a dead prostrate tree I noticed two or three common specimens of *I. cibarium* showing themselves among the low herbage; I collected them. On looking more closely I saw an olive-coloured egg-shaped fungoid substance peering up from the ground underneath a thick branch of the tree on which I was sitting, apparently as if it were pressed down by the branch. I broke the branch off carefully, when the egg-like substance rapidly burst open, and up sprang this fine specimen as if forcibly ejected by a spring, unfolding itself immediately to its full size. Its sudden and unexpected movement startled me; but after admiring this wondrous production of Nature, and its astonishing internal powers,—seeing, too, it was but a weak and flimsy tender substance without nerves,—I brought it carefully away in my handkerchief, and, after washing it with a feather in repeated waters (to remove its copious brownish slime of a most disagreeable odour, which is common to them all, including the closely-allied and handsome genus *Aseroe*), I dried it, and its volva or case, as a good specimen.

In former years (in the forties), before the introduction of cattle, specimens of *I. cibarium* were not unfrequently to be met with in open fern-lands, and generally fully expanded, usually from 3in. to 4in. diameter, and nearly globular; but I never before witnessed the bursting of a volva. The apparent strength, or power, shown by this small, soft, and tender fungus reminded me strongly of what we have read as recorded of some of the mushroom-like genus (*Agaricus*) in their displacing and forcing up the flat stones in city pavements.

As before stated by me in former papers read here, these fungi while in their young, unbroken egg-like condition were formerly eaten by the Maoris; in that state they have none of that offensive ill-odour that pertains only to the fully-expanded

pileus, and which is confined to the thick brownish slime with which it is covered: the difference is just that between a fresh-laid and an addled egg.

4. *Gentiana montana*, Forst. Another plant which I think should be included in this group as being both very rare and strange in this low wooded district is a species of *Gentiana*, and, as I believe, *G. montana*.

The natural home of this pretty little flowering-plant is on the open grassy tops of the neighbouring high Ruahine mountain-range, where it embellishes the small herbage of its sub-alpine locality with its numerous pale and neat flowers, which are large for such a small plant. I have only met with it in *one* small open spot on Tahoraiti Plain, where several plants of it grew; but I do not think it is to be found anywhere else in all the lower and wooded grounds. My detecting it there very much surprised me; indeed, as it was so long back since I last saw it growing on the mountains (in 1852), at first sight I supposed it to be a new species. Now, seeing that the seeds of the *Gentiana* are neither minute nor light (feathery), the question arises, How should it be found here on the plains so far away from its natural mountain-home?

5. Another fern, *Lomaria elongata*, Blume (*L. colensoi*, Hook.; *L. heterophylla*, Col.). The same reason which led me to bring forward the preceding plant causes me also to note here this fine and peculiar fern. Its original habitat, where I first detected it (in 1842), was on the banks of a brawling mountain-stream in the deep forests in the interior to the north-west of Lake Waikare, in the celebrated Urewera country, where, on those alluvial flats, it formed large and continuous strange-looking beds, through which it was difficult to force one's way, there being no path or track: this, however, was partly owing to the small driftwood and trees carried thither by heavy floods being concealed among its thickly-growing large fronds, so that one stumbled at every step, often getting ugly and painful knocks on one's shins. And here I may remark that, in travelling in those early times, and always on foot, in those places along the sides of streams in the wooded interior, the plan was to cross and recross the stream continually to the more open bank, there being no track whatever, the only guide for direction of one's course being the stream itself.

Here, however, in this Hawke's Bay bush district, I only know of one small isolated spot on the side of a mountain streamlet where it is found, and it grows there luxuriantly. I have never before met with it save in the interior. A few years ago, however, a settler at Woodville (an old Hawke's Bay resident), in clearing his section of land, found this fern there growing, and, being much surprised on seeing it, from its

novelty and size, and thinking it was new, sent me a specimen. It is a very striking fern, both from its large size and its strange appearance, and its equally curious manner of growth or disparity of form; and that not merely from its great difference in the barren and the fertile fronds (as obtains in other species of the *Lomaria* genus), but in its barren fronds, for, while its large fronds are usually very broad and coarsely pinnatifid, some of them are merely narrow, oblong, and simple (in this diform respect not unlike large specimens of *Polypodium billardieri*).

For my part, having given this fern much study, I am not inclined to believe it to be identical with *L. elongata*, Blume (a Javanese and Indian fern), as that species is largely drawn and fully described by Beddome in his "Ferns of Southern India." Sir W. J. Hooker, on my sending him specimens of this New Zealand fern, and finding I had published it with a description in the "Tasmanian Journal of Natural Science," in 1844, as *L. heterophylla*, immediately republished it with good drawings in his "Icones Plantarum," naming it *L. colensoi*, there being already a *L. heterophylla* described at Home, but unknown to me here in New Zealand.

II. PECULIAR AND PLEASING.

In this group I would place a few of our local ferns and some other plants, but only such as are not commonly met with, and, when found growing in undisturbed spots, serve to entrance the beholder, rivet his attention, and fill him with admiration—that is, if he possesses an eye to see, and a mind to understand. I will begin with that newly-detected neat little maidenhair, *Adiantum polymorphum*, Col.,* which, since I first made its acquaintance in 1887, I have found in three different secluded spots in these umbrageous forests, and in each place forming small continuous and closely-growing beds, flourishing beautifully, and presenting a delightful appearance, from their elegant form, graceful drooping habit, and uniformity of colour and of cutting, which is further increased on gathering a specimen and noticing more closely its slender glossy ebon stems.

Two other species of this genus—*A. hispidulum*, Sw., and *A. fulvum*, Raoul—I have also noticed in forests at the North (Bay of Islands), possessing a similar habit, growing closely in beds forming large patches, like this species; but those are much larger and coarser ferns, though fine specimens of *A. hispidulum* are very handsome.

Here I will briefly mention another newly-discovered and very fine fern (some specimens are truly beautiful), *Pteris*

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* Trans. N.Z. Inst., vol. xx., p. 215.

(Litobrochia) pendula, Col.,* and this I also notice because I have detected it in two other localities in this neighbourhood, but, as before (originally), hanging thickly down from shaded cliffy spots, sides of streamlets difficult of access. Some of the plants were very fine, of most luxurious growth, and looking tempting, so healthy and charming.

In three dry spots in particular, far apart from each other, in the deep forests between Dannevirke and the River Manawatu, I have often gazed with delight on thick-growing patches or beds of that extremely neat and graceful tender fern *Asplenium flabellifolium*, Cav., one of the most elegant of its genus. This wood variety (as I deem it) has much smaller pinnæ than this fern commonly has when growing in open places, and they are more finely and sharply cut, and its narrow linear fronds, being also much longer, give it a still more graceful appearance; its colour, too, is that of a most refreshing light emerald-green. All this, however, may naturally arise from its moist shady home in the forests. It forms compact and healthy beds by overlying itself considerably (*stratum super stratum*), the long and delicate fronds emitting at their extreme circinnate tips minute rootlets, which adhere to the soil when they touch it, when they again send out fresh stems, and so form new plants. This fern, however, is well known among us, and that deservedly, from its beauty as a living fern-decoration when suspended in a light wire basket, as well as from its being so easy of culture; and therefore I should not care to mention it here were it not that it is rapidly becoming very scarce, and those three spots in the dry and ancient woods were so exceedingly lovely that they have left their natural and truthful images deeply impressed on my mind; so true it is, "A thing of beauty is a joy for ever."

Having briefly noticed some of our smaller handsome local and rarer ferns, I will now say a few words respecting the bigger ones—the giants of the fern order—although many of them are generally very commonly distributed throughout the colony, and more particularly in the wooded districts.

Come on then, my hearers! Come with me into a secluded calm and quiet dell, in a deep-shaded forest, far away from the haunts of man! Let us go to a sacred spot well known to me, and still remaining free from the incursions of the ruthless invader, both quadruped and biped! May such concealment long continue!

Here, at the level bottom of this dell, down whose stony sides we have been scrambling, through which a small purling streamlet of clear water winds its tortuous way, stand a

* Trans. N.Z. Inst., vol. xx., p. 218.

group of majestic-looking tree-ferns, species of *Dicksonia;* they are about, say, 20ft.–25ft. high, and stand pretty far apart from each other, so that one can walk easily between them, and sit down, if so disposed, on the low and soft grassy herbage at their bases. Above, at top, their perennial crowns of large spreading green fronds extend, meeting and crossing each other — some horizontally, some gracefully drooping— while their stout upright stems are thickly clothed with their own dead and grey-brown fronds, hanging closely and not ungracefully down, wrapping them, as it were, in tolerably regular rows or layers from the base to the top, as if to protect their trunks, or even to keep them warm. Those dead hanging fronds are from their natural and regular yearly decay, and evidently not a single frond has ever fallen off or been displaced. They greatly add to the solemn and still beauty of the scene. If gently lifted their clean stems will be seen in all their rich brown colour and fibrous comeliness, without any small ferns, mosses, or other plants growing on them.

Such a spectacle, when undisturbed and deeply embowered and surrounded by ancient timber-trees,—

> Those green-robed senators of mighty woods,
> Tall oaks, branch-charmed by the earnest stars,
> Dream, and so dream all night without a stir.
>
> KEATS, "Hyperion."

—is to me a most pleasing one, causing me to behold it with 'bated breath, with a kind of feeling approaching to sentimental awe, better felt than expressed in those deep secluded forests — such a feeling as one might reasonably suppose would arise within the bosom of the wary and discreet visitor to the ancient oracle of Apollo at Delphos three thousand years ago. In such a place, and with such feelings in this retired solitude in the grand temple of Nature, the suitable words of Bishop Heber, so descriptive of "majestic silence," are likely to be vividly recalled to mind,—

> No hammers fell, no ponderous axes rung;
> Like some tall palm the mystic fabric sprung.
> Majestic silence!*
>
> HEBER, "Palestine."

But there is yet another and a very different sight to be seen and admired among my groups of big living tree-ferns—

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* This quotation from Bishop Heber's poem was altered in later editions to—

> No workman steel, no ponderous axes rung,
> Like some tall palm the noiseless fabric sprung.
> Silently as a dream the fabric rose,
> No sound of hammer or of saw was there.

I may here observe that these two last lines are also in Cowper's "Task," the Winter Morning Walk, book v.

one sure to evoke feelings of an opposite character in the bosom of the beholder, for, if the former were of the "Penseroso" class, these would as surely pertain to the converse or the "Allegro" one.

Here, then, in another umbrageous solitude, is a similar lot or small natural secluded grove of tall tree-ferns, generally of the genus *Cyathea;* but their stout stems are entirely without that solemn-looking dead grey-brown wrapping, and, instead, they possess a most beautiful and elegant closely-compacted light-green and glossy dress, composed of very small living creeping ferns, pendulous and thickly imbricated like tiles on the roof of a house, often delightfully glistening when visited by a passing ray of sunshine. These small ferns are mostly composed of two species only—*Trichomanes venosum*, Br., and *Hymenophyllum flabellatum*, Labill.—and they do dwell together apparently in the most pleasing harmony, as if enjoying life. They often completely enwrap the whole large and tall trunk of the tree-fern from base to apex, all green and flourishing, without showing the smallest spot of intervening open space, evidently the perennial and steady growth of many years. These little ferns are something more than of epiphytal development, pertaining rather to that of quasi-parasitical, for their creeping rhizomes and roots penetrate deeply into or among the outer dead matted stipites and fibres of the tree-ferns on which they flourish.

Perhaps I had better end here respecting the tree-ferns. But then you, my audience, "dwellers at home at ease," would only know half,—and that of my woodland *joys:* so it is but fair you should also know a little of my *sorrows*, otherwise you would remain in happy ignorance of them. These, however, I shall only briefly touch on, owing to the extreme disagreeableness of the theme.

And first of my majestic venerable-looking group. On my return on one occasion to one of those dear old haunts, I found, to my horror, that some Goth or churl had recently been there, and had set fire, separately, to each one of those eight or ten big tree-ferns! just to burn off their thick dry wrappings, the undisturbed growth of many years, and so to make a blaze; and there their blackened and half-charred stems stood, with their once lovely elastic crowns of fronds sadly scorched and stiffened above them—a piteous sight! I could fancy they even reproved me, and I could have wept.

I had long had good reasons for believing that my visits to that unfrequented part of that old forest, so difficult of access, were watched by one or more of the underlings or stockmen of the neighbouring sheep-station, who, I suppose, on his going thither after me, and not discovering what it was that could have induced me so frequently to visit that place (for the old

belief was that in such spots I was fossicking for gold), vented his disappointment in that way—by striking a match or matches and setting fire to those tree-ferns out of mere wantonness. Several such instances had occurred in former years during my sojournings at Norsewood, some of them having been caused by so-called "picnic" parties, and some by *teetotallers*—judging from the labels on the bottles left behind!

Before, however, that I quit this pre-eminently pleasing and loved subject of our New Zealand ferns, I would call your attention, and especially that of the young-lady portion of my audience, to an interesting, novel, and elegant sight I have several times seen and admired while residing in the bush; this, too, being an artificial and neat method of preserving them. To me, indeed, it was unique, never having before noticed anything of the kind.

A bunch or small bundle (I might almost term it a *bouquet-de-plumes*) of an assorted few of our larger ferns—viz., *Polypodium pennigerum*, *Lomaria fluviatilis*, *Asplenium lucidum*, *Adiantum cunninghamii* (the handsome species of maidenhair), *Hymenophyllum dilatatum* and *H. demissum*, and *Pteris (Litobrochia) pendula* (my new fern)—were loosely bound together much after the fashion of a sheaf of wheat, with the tips of the longer specimens gracefully drooping, and placed so as to stand erect on a black stand under a tall cylindrical glass with closed dome-shaped top. These were all perfect, pure-white—dead or frosted white like silver or tissue-paper, with every tiny leaflet fully expanded, and with the veins and seed-receptacles and capsules clearly and beautifully shown. The leaves, moreover, of some of them are thickish and obscure in their living state (as of *Asplenium lucidum*), but now they were equally thin and semi-transparent like those of the others.

I saw this elegant and peculiar specimen of art-decoration—so chaste and simple and yet so strikingly lovely—at the Club Hotel, in Woodville, in the larger parlour upstairs; I often admired it. There it stood, conspicuous among other ornaments, on the top of a high dark-coloured piano. I do not know how the remarkable change, which seems to be permanent, was effected; I made inquiries of the proprietor, but he being newly entered did not know. I am aware that very great alteration can be caused by bleaching vegetable fabrics with the fumes of burning sulphur, and this may have been so effected. Be that as it may, it seemed to me to be a new and easy mode of admirably and more completely displaying the hidden natural beauties of our lovely New Zealand ferns, and so I bring it to your notice.

One other little-known plant must not be omitted from

this list—namely, *Metrosideros tenuifolia*, Col.;* and this from its very peculiar manner of growth, its pleasing colour, and its strange homes. I only first detected this plant about a year ago, and then (like many others) it was confined to one spot, where, however, it grew abundantly. Since then I have noticed it growing in several places, but all similar—that is, on the sides of steep cliffs, all the better if somewhat concave. In such spots it revels, repeatedly overrunning itself, flourishing luxuriantly. It adheres very closely to the soil, like small-leaved ivy, in England, to trees. The great regularity of its little round and glossy leaves, and its numerous slender red branchlets, afford a charming picture. What an elegant plant for rock-work, and for a permanent stone or clay alcove or bower! But words fail to describe this lowly-living evergreen beauty.

There are yet some other peculiar plants, which, though small singly in themselves, and of no striking beauty to arrest the eye of the beholder, should not be overlooked, as they often impart, from their curious appearance and situation on the dead and dry overhanging branches of trees, additional solemnity to the shaded and secluded woodland scenery.

Of these are some of our larger and foliaceous tree-lichens, such as several species of the genus *Sticta*, viz.: *S. fossulata*, Dufour; *S. freycinetii*, Delise; *S. argyracea* and *S. carpoloma*, Delise; and *Usnea barbata*, Fries ("old-man's beard"), several varieties.

It is well known that lichens live to a very great age; they retain their vegetative and productive powers uninjured throughout the hottest and driest seasons on the highest and most exposed dead branches: although, on gathering them at such times, they crumble to fine powder in the act, yet, on their becoming wetted from rain or dew, they are soft and flaccid, and may be folded up without breakage or injury.

I have seen very large specimens of the above-mentioned lichens, some specimens of the *Usnea* (fitly termed "old-man's beard," being thread-like, bushy, and pendent), 1ft.–2ft. long; and some specimens of *Sticta* extending from 1ft. to 18in. in diameter, and very fully and complexedly branched, their branches flat and bearing much fruit, which is often curiously and regularly placed like little shields or saucers on their margins.

They are all very numerous, and grow to perfection in damp gullies, especially on overhanging trees and shrubs in their sides in sheltered declivities; and often, when they are of a large size, and sombre lurid leathery appearance, hanging from the bare and dead branches, they give an uncanny,

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* Trans. N.Z. Inst., vol. xxiv., p. 387.

weird-like aspect to the solitary scene. At such times, pictures from Goethe's "Faust"—particularly of Faustus and Mephistopheles ascending through the dry mountain-woods to the witches meeting on the Brocken—have been forcibly called to my mind, and I have thought how such pictures might be further improved by the addition of some of those large, flapping, strange-looking lichens to the naked and dead branches of those gnarled mountain-trees, even more so than by the artist's introduction of flitting bats into such a scene, as bats do not fly by night.

Furthermore, in those dry and stony hill-sides, when the soughing winds sweep fitfully over the arid barren plains around and above, and blow among the stiff and hardened thin-edged lichens hanging from their denuded branches, not unfrequently sharpish, shrilly, stridulous, and low wailing sounds are heard, which are not, however, unpleasant, and serve to increase one's strange thoughts and mournful feelings, especially if alone—much as Wordsworth has it,—

> In that sweet mood when pleasant thoughts
> Bring sad thoughts to the mind.

III. STRIKING, THOUGH COMMON.

A few plants that are very frequent on the sides of the railway-line between Dannevirke and Woodville, and almost sure to arrest the eyes of some of the passengers, from the oddness and singularity of their appearance, may here be briefly mentioned, and that because very often certain questions are sure to be asked concerning them, especially at this, the winter-*cum*-spring season of the year.

And first I would take two that are often seen growing together close to the railway-lines, upright, single-stemmed, and pretty nearly of the same height (3ft.–6ft. or so), one a small young tree-fern (probably a *Dicksonia* or a *Cyathea*), and the other a young "cabbage-tree" of the settlers (*Cordyline australis*). These, with all the herbage and small evergreen shrubs that grow thickly around them, have been lately set on fire (I suppose, to clear the sides of the railway-line); and while the herbage and shrubs have been thus destroyed—burnt up—these two plants are still living, and fast shooting their large bright-green leaves and fronds from their tips and so forming living crowns, while their stems present a hideous black appearance, as if not only scorched but thoroughly burnt and killed, the whole of their bark and outer woody layers having been destroyed; increased, if possible, by the great contrast in colours, shown in their long dry and pale faded leaves hanging irregularly down from their tops; these leaves having been scorched and killed by the fire, but being thick and green were not completely burnt up. And the question

is almost sure to arise from some one observant person in the carriage, "Why is it so? Why are these two plants alone so salamander-like as to live through the terrible ordeal of raging fire?" And mark, this inquiry arises from only *one*, who may be laughed at for it by the company—the many,

> With the loud laugh that spoke the vacant mind.

For to the many there is nothing to be seen, nothing to be noticed, nothing worthy of observation in the whole scenery through which we are passing on both sides, whether botanical in charming variety and profusion, or geological as revealed by the varied horizontal strata in the sides of the deep cuttings through which we frequently thread our way. Such unobservant travellers and tourists too often remind one of Wordsworth's "Peter Bell":—

> A primrose by a river's brim
> A yellow primrose was to him,
> And it was nothing more.

Of course, the answer to that question is an easy one, though the cause may not be known to all: these two plants belong to the endogenous class, whose living woody system is internal and central, and not on the outside, under the external bark, like those others of the exogenous class around, that have at the same time been burnt and so perished. Large tree-ferns 20ft. to 25ft. high are frequently to be seen on the edge of or a little way within a burnt forest—that is, their blackened burnt stems standing like charred and sooty pillars, while from their tops large crowns of young bright-green fronds are springing and spreading, and so presenting a curious and strange contrast. At the same time, not a single tree or shrub of that forest has escaped the ravages of the fire; all besides is dreary desolation, vegetable death.

There is yet another plant that is very common in the woods near the railway-lines which, from the great singularity of its appearance, deserves notice. It grows only on the upper large branches of trees, where it forms round ragged bunches of rather long grass or leek-like leaves, and sometimes several of such bunches are together, forming quite a big mass. It shows itself more conspicuously and strangely when growing on dead burnt and still standing trees, which is very frequently the case, and has often astonished me from its tenacity of life. How those small and feeble and exposed plants escaped the fiery doom which destroyed the big and stout trees root and branch on which they are still living and flourishing is a mystery to me. Further, the bark of many of those burnt trees has peeled off, leaving only their pale, bleached, denuded limbs, on which those plants still adhere

and grow and live, which serves to make their appearance the more singular.

This plant is a species of *Astelia*, and probably *A. spicata*, Col.,* which species, as far as I know, is confined to this wooded district. There are several species of this genus known to inhabit New Zealand, and some of them are of a very large size, especially in the northern woods, where, high up in the lofty trees, they resemble huge crows' nests.

And now, my audience, I have done. Believe me,—

> There is a pleasure in the pathless woods;
> There is a rapture on the lonely shore;
> There is society where none intrudes,
> By the deep Sea, and music in its roar:
> I love not Man the less, but Nature more.
>
> BYRON, "Childe Harold."

ART. XLII.—Cryptogams: *A Description of a few Lately-discovered Rare Indigenous Ferns; also, Notice of a Fine and Peculiar Fungus,* Ileodictyon, *Tulasne,* = Clathrus, *Cooke.*

By WILLIAM COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

Order I. FILICES.

Genus 11.† **Adiantum**, Linn.

1. *A. pullum*, sp. nov.

Rhizome as stout as a goose-quill, creeping, densely hairy and scaly; hairs reddish-black; scales black, large, acuminate, glossy. Plant 6in.–8in. (sometimes 10in.–11in.) high, suberect and drooping, ovate and subpedate; several fronds springing close together from rhizome, 6–8 within 1in.; stipes (and rhachises) very slender, almost filiform, black, glossy, mostly curved or irregular not straight, 4in.–5in. long, rarely 6in.–7in., channelled on upper surface, slightly scaly below and semi-muricatulate; frond 3in.–4in. (sometimes 5in.–5½in.) long, always more or less dark-coloured on both

* Trans. N.Z. Inst., vol. xiv., p. 335, for *m.*, and vol. xv., p. 340, for *f.* plant.

† The numbers attached to orders and genera are those of them in "Handbook of the Flora of New Zealand."

surfaces, some pinnæ are nearly black, glaucescent below, usually bipinnate and tripinnate, generally 3 sometimes 4 rarely 5–6 branches long curved pinnate; pinnules alternate, rather distant, patent on long filiform petioles, mostly small, of various shapes and sizes on the same plant, broadly cuneate, parallelogrammiform, roundish-oblong, suborbicular and subrhomboid, 2–3 lines long rarely 4–5, gradually decreasing in size to tips, the upper pinnules close and very small, the ultimate one rhomboidal obtuse; the lower margin (or sometimes 2 margins) being the continuation of petiole always thickened straight even glossy and coloured; the upper margins cartilaginous laciniate and serrate, teeth large white hard and sharp; veins numerous, close, free, much dichotomously and flabellately branched, several pairs rising and spreading from a single basal vein, and all subradiating from the petiole or lower basal angle. Sori few but of a large size and very prominent far beyond margin of involucre, on the lobules and not in the notches of the pinnules. Involucres brown shining (black in age), rather large, their margins gaping elevated, generally 5–7, sometimes 9, on the larger pinnules, on the upper margin and partly extending round the outer or tip; smaller and very close together on the small, and only 1, 2, or 3 on the smallest pinnules; sinus deep; when young, however, they are very thin white and crisp, or crumpled.

Hab. Open land, damp shaded spots rocky places, between Dannevirke and the East Coast, County of Waipawa; 1892: *Mr. H. Hill.*

Obs. I. This fern has given me much extra labour, from its possessing some of the common characters of *A. cunninghamii*, Hook. (*A. affine* of some modern writers on ferns; but *quæ.*), and of other allied species (particularly *A. heterophyllum*, Col., Trans. N.Z. Inst., vol. xx., p. 218); but (as I fortunately possess a large number of specimens of all sizes, through the liberality of its kind discoverer) I believe it to be very distinct as a species. Those "common characters" pertain more or less to all that sub-family of *Adiantum*, most of the species also being exotic. Of this fern, its manner of growth, its black filiform stipes (indeed, the almost general blackish colour of the whole plant), its large black and shining scales, its small and variously-shaped pinnules, and, above all, their laciniate and sharply serrate margins, with compound and radiating veins and venules, afford good and constant characters.

II. I have not infrequently met with, and possess, dwarf specimens of *A. cunninghamii* (some being little pigmies), as well as extra-large ones, but these do not contain the peculiar and distinctive characters of this fern.

Genus 13. **Cheilanthes**, Swartz.

1. *C. venosa*, sp. nov.

Plant slightly tufted. Stipe suberect and curved, 3in.–3½in. long, very slender almost filiform, terete, lightly furrowed on upper surface near base, glabrous, light-red and glossy (as, also, rhachis and subrhachises), with a few small weak scales scattered throughout. Frond 2in.-3in. long, sub-deltoid-ovate, 1½in.–2in. wide at base, apical lobe very large (for plant), deeply incised obtuse; bipinnate light-green, glabrous, with a few distant scattered fine weak and rather long white hairs on both surfaces; pinnæ 4–5 jugæ; 3 lower pairs opposite, distant ¾in.–1in. on rhachis, sub-deltoid-ovate, 1in.–1½in. long, about 1in. wide at base, petiolate; uppermost pairs subsessile and pinnatifid; pinnules ovate, obtuse, pinnatifid, deeply incised, lobed; lobes oblong; tips of lobes and lobules irregularly bluntly toothed, much veined; veins pinnate, free, regularly branching from midrib, largely dichotomous, each lobe and lobule containing many straight venules and veinlets, extending to margin. Sori loosely scattered, generally on tips of pinnæ and of lobes in irregular little batches, mostly very small, sometimes mere dots. Involucre green from the incurved margin of frond, small and (sometimes) 1–2–3-cleft and toothed, rarely covering sori.

Hab. Dry hills, among low shrubs and undisturbed indigenous herbage, in various localities in the County of Hawke's Bay; rather rare, nowhere common.

Obs. I. This is a very neat little fern; its fresh and charming green colour alike on both sides (which it also retains in drying), and its light-red glossy filiform stipe and rhachises, give it an elegant appearance, which is also increased on examination and observing the curious disposition of its sori and involucres, and its remarkably regular and curved numerous venation.

II. I have known this fern for a considerable time, but only during this year (1892) have I succeeded in obtaining really good specimens. I think its fronds are annual or biennial. Old states, more or less dried up, are difficult to examine closely and satisfactorily, and much resemble those of *C. tenuifolia*, Swartz, to which species (and also to *C. sieberi*, Kunze) it is pretty closely allied. But from *C. tenuifolia* it differs in several particulars (*vide descript.*), and most especially in its peculiar and striking venation, which does not vary, and forms a good specific character. Sir W. J. Hooker has given a drawing with dissections of *C. tenuifolia* (likewise of *C. sieberi*) in his "Species Filicum," of which he also says, in his description of that fern, "Our figure will give a better idea of the plant than whole pages of description can do".

(*l.c.*, vol. ii., p. 83): there the venation of the pinnules is shown as extremely simple and distant and not extending to margins. And just so it also is shown in the larger drawings with dissections of *C. tenuifolia* given by Beddome in his "Ferns of Southern India," plate 188 (also referred to by Baker in his description of that fern in his "Synopsis Filicum"). There the veins in the lobes are simple and common, showing the midrib from the rhachis with 3–4 single veins on each side that do not reach the margin in each lobule; also the involucre continuously extending over 3 lateral and 4 apical veins, with its margin even. Moreover, *C. tenuifolia* is shown to be a much larger and coarser fern, tripinnate with 5–6 pairs of pinnæ, its lower pinnæ compound (or tripinnate) with longer petioles, their tips, with that also of the frond, being subacute; and in his description of this fern he also says, "Stipe and rhachis purple-black; the main rhachis is winged above, and the secondary and tertiary rhachises are all narrow-winged" (*l.c.*, p. 64); and Sir W. J. Hooker says the same in "Species Filicum," p. 82—characters that are not found in this fern, *C. venosa.*

Genus 16. **Lomaria**, Willdenow.

1. *L. pygmæa*, sp. nov.

Plant very small, tufted, 2in.–3in. high; subcaudex an erect thick bunch of old stipites ¾in.–1in. long, with numerous long black scales, acuminate, acute, glossy; roots long, spreading, terete, glabrous. *Barren frond* spreading linear-lanceolate, 1½in.–2½in. long, 2–3 lines wide at middle, pinnatifid, submembranous, pea-green, glabrous, glossy above, rhachis channelled; pinnules 13–15 on each side, alternate, regular, semi-orbicular or hippocrepiform, very small at base, apical lobe subacute with pinnate veins; margins slightly uneven, subcartilaginous, whitish; veins few, 3–4 pair in each pinnule, simple and forked, extending to margin, tips clavate; stipe slender, short, sub ½in. long. *Fertile frond* shorter, suberect, very slender and narrow, linear, 2in. long, $\frac{1}{10}$in. wide, pinnate; pinnæ alternate, orbicular, about ½ line diameter, sessile, about 13 pinnæ on each side of rhachis, the lower and middle ones distant, the lower most minute, apical lobe 4 lines long. Sori numerous, spreading, close, compacted, covering pinna, dark-brown. Involucre narrow, dark-coloured, reverted, margins entire.

Hab. Open lands, damp spots rocky places, between Dannevirke and the East Coast, County of Waipawa; 1892: *Mr. H. Hill.*

Obs. A peculiar little species: its very small size, venation, and minute orbicular fertile pinnæ distinguish it readily from all others of the genus.

2. *L. procera*, var. *gracilis*, Col.

Plant tufted, erect, very slender; roots numerous, bushy, densely and finely hairy; hairs red. *Barren fronds* suberect and drooping, 9 in number from 1 rootstock, of various lengths, 4in.–8in. long, 1½in.–2in. wide, linear-lanceolate, pinnate; stipe 2in., almost filiform, pale-reddish, dry, sulcate above, very slightly scaly; pinnæ very thin, pale-green, alternate, few, 7 on each side of rhachis in longest specimen and 4 on short ones, sub-linear-elliptic, the longest 1in. long and 4 lines wide, patent and slightly falcate, subacute and obtuse, midrib very narrow, deeply channelled above with raised edges, margins sharply serrulate the teeth curved upwards and long, and close at tips, dimidiate, base truncate, the upper half more so, petiolate, petioles short very slender, ¾in.–1in. distant on rhachis, upper pinnæ subsessile, acute, the lower half decurrent, apical lobe linear-ovate acuminate, 1½in. long, the lowermost pinnæ very small, suborbicular, 3–4 lines diameter; veins simple, rarely forked. *Fertile frond* erect, pinnate, 10in. long, 2½in. wide; stipe 6in., much stouter than in the barren fronds but not 1 line wide, red, glabrous; pinnæ alternate distant, 6 on each side of rhachis, very narrow-linear, 1in. long, $\frac{1}{10}$in. wide, sessile and decurrent, the lower pinnæ 1½in. distant on rhachis, the upper 3 pairs closer, apical lobe 1½in. long, the lower fruiting pair of pinnæ subsessile, and the lowermost pair of pinnæ barren very small 4 lines long broadly ovate tips rounded. Sori numerous, compact, dark-brown, not extending to tips of pinnæ, which are leafy 1–2 lines long, and so also the lower fruiting pair at their bases. Involucre dark-brown, subinvolute and adhering, very finely fringed throughout.

Hab. Open margin of low wood, edge of great plain south of Dannevirke, County of Waipawa; 1892; scarce: *W.C.*

Obs. I again visited that spot with difficulty, on recovering slowly from illness, in the autumn of 1892, and managed to bring away one entire and perfect plant, which looked surpassingly graceful in its sheltered home; and, although *primâ facie* it seems so very different from all the (known) varieties of *L. procera*, yet, on careful examination and comparison, I am obliged to consider it to be but another variety of that variable species.* Its striking points of difference are—its slender, graceful, and neat appearance; its few, thin, small, distant, obtuse pinnæ, with their finely-serrulate margins; its filiform and long stipes; and its densely-hairy and red roots.

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* Sir J. D. Hooker, in his "Handbook of New Zealand Flora" (published thirty years ago), gives four varieties, of which he says, "The varieties enumerated keep their characters under cultivation." Some of them both Cunningham and myself had considered to be good and valid species, and to that number others have been added since.

Order VIII. Fungi.

Genus 24. **Ileodictyon**, Tulasne.

1. *I. (Clathrus) giganteum*, Col.

Receptacle pyriform, 14in. long, 9in. wide, white; interstices very large (some 4in. by 2in.), pentangular; ribs 6–8 lines wide, much and finely crumpled, with small triangular apertures in the middle of the rib at each outer angle. Volva ovoid, white, thick, skinny, gelatinous within, with long white rootlets.

Hab. On ground, edge of forest south of Dannevirke; 1892: *W. C.*

Obs. I. For a more particular account of this fine and highly curious fungus, including its peculiar manner of unfolding from its volva, see my paper, "Bush Jottings" (*supra*, Art. XLI.).

II. Since writing that paper I have received a copy of Dr. Cooke's "Handbook Australian Fungi" (lately published), and I find that he has removed *I. cibarium*, our more common New Zealand species, into the allied old Linnean genus of *Clathrus;* and also given a drawing of *I. cibarium*, with its description (*loc. cit.*, p. 215), and this serves to settle my doubt as to the validity of this species.

Art. XLIII.—Phænogams: *A Description of some Newly-discovered Indigenous Plants; being a Further Contribution towards the making known the Botany of New Zealand.*

By William Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

Class I. DICOTYLEDONS.

Order I. Ranunculaceæ.

Genus 3.* **Ranunculus**, Linn.

1. *R. sychnopetala*, sp. nov.

Plant large, tufted; radical leaf suborbicular, 3in. long, 3½in. wide, apex slightly produced rounded and subtrilobed, base truncate and in a small degree turned up over lamina close to petiole, thickish, soft, upper surface green slightly hairy, the under-surface paler and more hairy; hairs weak

* The numbers of the orders and genera given here are those of them in the "Handbook of the New Zealand Flora."

wavy reddish, thicker longer and subciliate at margins; 9–10-veined; veins pale, sunk in the upper surface, slightly conspicuous beneath; veinlets closely anastomosing, forming long narrow angular areoles; margins coarsely and irregularly crenate-serrate; petiole 1¾in. long, 2 lines wide, stoutish, brown, hairy; hairs long appressed strigillose reddish; stipules at base small narrow. Flowering-stems 9in. high, solid, stout below nearly ¼in. diameter, two springing together from a single basal leaf; leaf subovate acuminate, stout, lamina 3½in. long 1¼in. wide many-nerved (9); veinlets anastomosing; tip very obtuse; lateral margins coarsely serrate with 6–7 broad teeth, gradually tapering to base; petiole 1in. long, very broad flattish and thick, nerves continued down petiole; small stipules at base; each flower-stem trichotomous 4in. from base, surrounded by a pair of bract-like sessile oblong leaves 1½in. long; pedicels 1-flowered, stout, sub 6in. long, with (in one specimen) a whorl of three leafy bracts about the middle, subovate sessile, irregular in size and in cutting, the largest having a pair of large lateral teeth almost trifid, the others entire, hairy, margins ciliate; hairs wavy reddish; and in the other specimen with a single trifid bract. Flowers: Calyx pale greenish-yellow; sepals 5, linear obovate, ½in. long, sub 2 lines wide, tip obtuse, concave, distant, hairy, margins ciliate, much veined; vein single at base, 5-branched at middle and united at top. Corolla pale-yellow glistening, 1in. diameter; petals numerous (40–45) in 3 rows, recurved, cuneate, 8 lines long 2½ lines wide, much veined, more so than sepal; tip rounded very obtuse entire; base tapering, claw long; gland small orbicular, about 1 line above base. Anthers numerous, stout, before bursting broadly elliptic, afterwards elongated and much narrower, deeply channelled on back, very glossy, same colour as petals; stamens broad flattish as wide as anthers, 2-nerved. Carpels 0, but instead a few small greenish petaloid leaves, much incurved and forming a small green ball.

Hab. Ruahine Mountain-range, east side, near summits of lateral spurs; 1891: *Mr. A. Olsen, Norsewood.*

Obs. Of this fine and very peculiar plant I have only received two flowering specimens, both, however, in good condition. At first I thought it to be a "monster" flower of *R. insignis*, Hook., or of *R. ruahinicus*, Col.; but after a very close and patient examination and comparison I find it to be distinct, though, from its not possessing any carpels, but numerous small petals in their place, it may prove to be a "monster" (or double) flower.

2. *R. longipetiolatus*, sp. nov.

Plant erect, glabrous, stolons few, short. Roots numerous long wiry very slender; sometimes rooting at lower nodes of

flowering-stem. Leaves few, single, on tops of long petioles, spreading, in circumscription subreniform and narrow hemispherical, 1½in.–2in. long, 2½in.–3in. broad, trifoliolate, each lobe largely petiolulate subflabelliform and broadly cuneate, trilobulate, sinuses deep obtuse and very wide, lateral margins always entire, lobules trifid (and variously laciniate), generally with 1 large central and 2 small teeth their tips obtuse; petiolules slender sometimes 1in. long, veined; lamina thin largely veined, with numerous compound anastomosing veinlets and venules; petioles fistular, 7in.–10in. long, stout when fresh, with a long narrow stipule at base. Flowers few small, single on long erect peduncles, some directly from the rootstock 9in. long, others (and generally 1–3) distant on flowering-stem, axillary from a single cauline leaf and twice the length of its long petiole—sometimes 4in. long, occasionally 2 flowers springing together axillary on separate pedicels. Sepals 5, much shorter than petals, concave, inflated, tawny, glabrescent, 2½ lines long, broadly-ovate or oblong-rounded, tips very obtuse, 3-nerved, nerves flexuous; margin very membranous, white, pellucid. Petals 6, flat, narrow linear-spathulate, 4½ lines long, sub 1 line wide, tips obtuse and emarginate, tapering to base, pale-yellow glabrous, 5-nerved; nerves straight branching above not extending to tip; gland near base small, reaching across petal, hollow, depressed. Stamens short, sub 24; anthers elliptic slightly subapiculate. Achenia orbicular, turgid, sub 1 line diameter, slightly rugulose-muricatulate; styles same length, curved, slightly puberulous; stigma capitate, subpenicillate. Receptacle small elongated oblong subclavate, coarsely hairy at base.

Hab. In watercourses, forests near South Norsewood, County of Waipawa; 1882: *W. C.*

Obs. This species is certainly near to *R. macropus*, Hook., but on a close examination and comparison there will be found several grave differential characters. Indeed, it was owing to my having supposed it to be that species, or a variety of it, that I have so long delayed describing it; and to this opinion I was in great measure led through merely reading the specific description of that species as given in the Handbook. Besides, I had intended to revisit Norsewood and to obtain more and fresh specimens—which also caused me to put it off—which I have never since done. Now, however, on referring to the full and particular specific description of *R. macropus* (the type specimens found by me at Poverty Bay in 1839), as originally given by Sir Joseph Hooker in the "Icones Plantarum," accompanied by a drawing and dissections (vol. vii., tab. DCXXXIV.), the differences are plain and great, and clearly shown in the drawing. That species has *much larger sepals than petals,* which peculiar character also caused Sir Joseph

Hooker there to observe, "A very remarkable plant . . . from the smallness of its petals as compared with the sepals." Besides this there are several other differential characters in its leaves, flowers, and fruit.

Order VI. CARYOPHYLLEÆ.

Genus **Cerastium**,* Linn.

1. *C. truncatulum*, sp. nov.

Plant annual, small, erect, 1in.–2in. high, simple, sometimes slightly branched, very hairy; hairs patent not viscid. leaves, radical subrosulate linear-spathulate, smaller than those on stem; stem-leaves linear-oblong obtuse, 3–5 lines long, sessile, dark-green, margins purple, ciliate; hairs jointed, white. Flowers 2–4, axillary near top, and 1 terminal, rather large for plant, open, 2 springing on long pedicels from one of pair of opposite leaves, pedicel ½in. long, slender, bibracteate at middle. Calyx shorter than petals, 2½ lines long, lobes subacute, green, purple-tipped, with large white membranous margins. Petals longer than calyx, bifid half-way down, lobes acute; styles 5, long, hairy; capsule twice as long as calyx, stout, slightly curved, shining with 10 teeth; teeth short, very broad, tips truncate and notched. Seeds numerous, orbicular, muricated, ochraceous.

Hab. Open grassy plains south of Dannevirke, County of Waipawa; 1887–91: *W. C.*

Obs. I have long known this little plant, and have often slightly noticed it, supposing it to be an introduced British species (two or three of them being now common here, imported among grass- and clover-seeds), but during this spring (1891) I was led from its humble beauty to gather and closely examine it, and believe it to be a new and undescribed species, the teeth of its capsule being so very different from those of all other species known to me, and so affording a good differential character. The plant has some general resemblance to *C. semidecandrum;* it is an early spring flower.

Order XVIII. RHAMNEÆ.

Genus 1. **Pomaderris**, Labill.

1. *P. mollis*, sp. nov.

Shrub 9ft. high, upright handsome growth, branched from base; branchlets densely stellate pubescent, also petioles under-surface of leaves flowering-stems and calyx on outside. Leaves alternate distant softish, usually 1in.–2in. apart, ovate,

* This genus is not inserted in the "Handbook of the New Zealand Flora," although those others very near it are—*Stellaria*, *Spergularia*, &c.

3in.–4¼in. long, 1¾in.–2⅛in. wide, tip obtuse, base rounded; also, often irregular in size and shape, some being much smaller, 1in.–1½in. long, elliptic, tip much rounded, on same branchlet with the large ones and generally below them; margins denticulate sub-crenate-serrate, dark-green, deeply rugulose, glabrous and shining above with sunken nerves, pale dull-green and stellate-hairy below, the hairs white and regularly scattered (not crowded) on lamina, but reddish and densely close on midrib and veins; veins few, regular, much produced, diagonal, parallel 4 lines apart, their tips branched on the posterior side; petioles stout, soft, ¾in. long, terete, slightly sulcate on the upper surface, closely hairy. Flowers in large loose compound terminal (and subterminal) panicles, 5in.–6in. long, 7in.–8in. broad at base, subpanicles 4in.–5in. long, with a small leaf at base, their branches loose distant slender spreading. Flowers close, soft, subfascicled 3–6 together; pedicels about 1 line long; calyx pale-green, 1½ lines diameter, 5-parted, sepals ovate recurved, keeled above, densely stellate-hairy on outside, tube very short; petals 0; anthers subobovoid, obtuse, orange-coloured, filaments flattish erect a little longer than style; style stout furrowed, top 3-cleft one-third of its length; stigmas large, capitate, rough. Ovary hairy, with scattered adpressed stellate hairs and also other hairs simple erect acute as long as style. Capsule rounded, the exserted part as long as the adnate tube, dark-brown. Cocci whitish-brown, elliptic subapiculate, submembranous, convex keeled on inner face and opening by a basal slit extending half-way up, minutely puberulous.

Hab. Dry hills near Puketapu, west of Napier, Hawke's Bay; rare; 1890–92; flowering 10th November: *W. C.*

Obs. This shrub is certainly very near to *P. tainui*, Hector,* differing, however, in size of plant, form, &c., of leaf, and wanting its gland to anthers, &c.; and as I have already noticed and described† how closely two (at least) of our northern species of this genus approach each other until they are fully examined, just so it may be with these two plants. At all events, if this plant should prove to be identical with that species, then another legendary Maori support and witness (!) of their wild, mythical canoe-arrival on these shores will again have to be abandoned—with regret, not only by themselves, but also by their European supporters.

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* See Trans. N.Z. Inst., vol. xi., p. 428. Sir James Hector says, "flowering 5th December," "capsule not seen." His specific description of the plant is consequently imperfect, but his account of its discovery, &c., is interesting and worthy of perusal.

† See Trans. N.Z. Inst., vol. xviii., p. 258: *P. amœna*, Col., and *P. phylicifolia*, Lodd.

Order XXII. Leguminosæ.

Genus 1. **Carmichælia**, Br.

1. *C. multicaule*, sp. nov.*

Shrub about 10ft. high erect, many stems close together from one rootstock, the thicker ones being about 3in. diameter and very irregularly grooved and corrugated, bark smooth; stems below for 3ft.–4ft. from ground bare of branches; above the branches are very numerous suberect and dependent; the smaller branches long slender terete sub 1 line diameter, slightly geniculate; branchlets very numerous, alternate about 1in. apart, the ultimate ones simple straight 7in.–10in. long, very narrow $\frac{1}{20}$in. broad, dark-green, striate, with small scarious marginal bracts $\frac{1}{2}$in.–$\frac{3}{4}$in. apart. Leaves 0. Flowers not numerous, on some large branches none, alternate in small panicles containing 7–11 flowers $\frac{1}{2}$in.–1in. apart; peduncle with 1 deltoid brown bract at base slightly cut; pedicels 1–2 lines long, slender, much pilose, margins densely ciliate, hairs pure-white, striking, with many small scattered brown bracteoles. Calyx rather large, free, inflated, green, glabrous, submembranous, margins toothed; teeth black very prominent. Corolla small open variegated; standard oblate-orbicular 2 lines broad, largely retuse, much recurved, dark blue-purple with white margin, veined; wings linear-oblong thin white, longer than keel, their tips broad rounded, reddish; keel subreniform $1\frac{1}{2}$ lines long, whitish, tip rounded pale-reddish. Filaments very slender capillary, pellucid membranous, flexuous; anthers small, elliptic, fawn-coloured; style very long, curved, persistent; stigma rather large, capitate, thickly puberulous. Pod narrow-oblong 4 lines long including long stout beak, glabrous, dark-green young; beak very stout subulate, 1–$1\frac{1}{4}$ lines long, sublanceolate contracted at apex of pod.

Hab. Open grassy flats in gullies south of Dannevirke, County of Waipawa; 1889–92: *W. C.*

Obs. This shrub is peculiar from its habit and manner of growth; its main stems are curious objects, being so close together and numerously and largely furrowed with their bark unbroken. I have long known the plant, and have often visited them seeking flowers or fruit, but have always been disappointed until this year, 1892, when, in November, I was gladdened on seeing many healthy young flowering buds showing themselves; fortunately I secured some specimens, though very young, and when I visited again before Christmas (almost purposely) I found but *very few* flowers and immature pods, and these only on one of the many branches. Of all the others I had seen the month before, there was now no trace. It is evidently allied to *C. corymbosa*, Col. (Trans. N.Z. Inst.,

vol. xxi., p. 80), but differs in several characters. Sheep rest under its shade, and cattle browse on its young drooping branches, often without biting them off, owing to their toughness, leaving an unsightly chewed mass of dead hanging fibres; just as they do with chewed *Phormium* leaves, and the young flowering-culms of *Arundo conspicua*.

Order XXXIX. Compositæ.

Genus 1. **Olearia**, Mænch.

1. *O. fasciculifolia*, sp. nov.

A low bushy shrub, 4ft.–5ft. high. My single specimen, top of a branch 6in. long, contains many close subdecussate branchlets, from 5in. to 1in. in length, the longer ones being again branched. Branchlets erect and suberect, slender, straight, opposite, semi-whorled, angled; bark reddish-brown, striate, with more or less of orange-coloured dry waxy exudation, which is also scattered on leaves and more largely on involucre. Leaves few, distant, fascicled in 3 and 4, opposite, erect and patent, linear-oblong or sub-linear-spathulate, 1½–2 (rarely 3) lines long, less than 1 line wide, thickish, tip rounded, base tapering, margins entire narrowly revolute and appressed, dark-green glabrous above, greyish-white below with closely-appressed hairs; lower half of midrib prominent below; petiole short, stout. Heads single, scattered, axillary on lower half of branchlets, sometimes 2 together subfascicled, campanulate, 2 lines diameter; pedicels short, sub 1 line, stout. Involucral scales many, imbricate in 6–7 rows, orange-coloured with blackish dark-green central stripe, the lowermost small, obtuse; middle much larger, ovate, acute; innermost row very narrow acuminate, 2–2½ lines long. Florets few, produced beyond pappus, black when dry, very slender, weak, subreflexed. Pappus scanty, straight, glossy, nearly equal, scabrid, white, tips acute. Achene semi-terete, linear, 1 line long, grooved, thickest at top, pale, glabrous, shining. Disc smoothish, shining, pitted.

Hab. Open lands between Dannevirke and Weber, County of Waipawa; 1892: *Mr. H. Hill.* Flowering late in May.

Genus 17. **Senecio**, Linn.

1. *S. multinerve*, sp. nov.

"A low spreading shrub, about 4ft. high." My specimen, a branch 9in. long (torn off from a larger one), shortly spreading into 3 slender erect branches, glabrous (and slightly-scattered puberulent whitish hairs), bark furrowed reddish-brown. Leaves few, distant, scattered, thin, spreading, oblong-lanceolate and linear-elliptic, 1in.–1¾in. long, 4–6 lines broad, tips very obtuse subtruncate, base tapering, glabrous above,

slightly scabrid-puberulous below; margins thickened, coarsely and closely toothed, teeth knobbed; veins below very reticulate and dark; petioles slender, 4–8 lines long, grooved above, puberulent. Flowers bright-yellow, close, showy, in terminal corymbs beyond leaves; peduncles 1in.–1¼in. long, filiform 3-flowered, with a long narrow leafy bract at base; pedicels spreading, slender, 4–5 lines long, a long bract at the base and 2 linear bracteoles above the middle. Heads rather small, campanulate, 4 lines long. Involucral scales 5, oblong, slightly puberulent above, the 2 inner very broad 4-nerved, with large membranous margins, their tips rounded and ciliolate, the 3 outer narrower. Florets few 7–8, 2–3 ray, 5 disc; lamina of ray broad for size of flower, 7-nerved, tips revolute. Pappus numerous, a little shorter than florets, rather harsh, glossy, white, scabrid, unequal. Achene linear, glabrous, obsoletely ribbed dark-brown. Disc alveolate, edges raised rough.

Hab. In a valley near Tolaga Bay, East Coast; rare; 1892: *Mr. H. Hill.*

Obs. This plant is certainly closely allied to *S. perdicioides*, Hook. f., also a very rare plant from that same locality, discovered by Banks and Solander on Cook's first visit to New Zealand. I have been in doubt about describing it as being distinct; but there seem to me to be certain grave characters pertaining to it, which, if in *S. perdicioides*, could not have been unnoticed by Hooker, as—its margined and knobbed leaves (which are also of a different form), its peculiar and handsome inner scales of the involucre, and its long bracts and bracteoles.

Order XLII. ERICEÆ.

Genus 8. **Dracophyllum**, Labill.

1. *D. imbricatum*, sp. nov.

(My single specimen) a branch 17in. long, simple, straight, stout, as thick as a goosequill at base, base there for 3in.–4in. with dark-brown bark, light-reddish and ringed above where denuded under leaves—apparently a strong, healthy, vigorous young branch. Leaves numerous, close, erect and squarrosely spreading, linear, 4in.–5in. long, 4 lines wide, rather thin yet opaque, smooth, dry, concave, pale-green, glabrous, margins slightly and closely serrulate, tapering to apex, tip long, very narrow and acute, bases dilated ⅓in. wide, reddish, imbricate and largely amplexicaul; the upper leaves erect extending as high as panicle. Flowers terminal in a narrow contracted erect raceme-like panicle, 2in.–2½in. long, sub ⅓in. wide; bark glabrous, dark-brown, much grooved; few flowers, 3–4 on short branchlets, each branchlet with a long linear bract at

base, keeled and submucronate; pedicels about 1 line long; calycine bracts half as long as corolla, ovate, concave, finely serrulate, tips produced, acute. Corolla 4 lines long, narrow campanulate, reddish-orange, lobes shorter than tube, sub-deltoid-ovate, lateral margins much incurved, whitish, tips narrow revolute. Anthers linear-elliptic, 2-lobed, included; filaments free twice as long as style; style 1 line long, slightly puberulent, stoutish, cylindrical, simple; hypogenous scales sub-linear-ovate (or lingulate), broadest at base, truncate and notched at tip. Ovary very small, scarcely 1 line diameter, with 5 minute rounded protuberances at top.

Hab. Open lands near Cape Runaway, east coast, North Island; 1892: *Mr. H. Hill.*

Obs. Apparently this striking species is allied to *D. strictum*, Hook. My specimen is a large one, though sadly crushed in long carriage in a saddle-bag, especially its more tender flowering part; sufficient, however, remained to enable me to describe it. Better flowering and fruiting specimens are wanted; also to know more about the size and shape of the shrub.

Order LIII. Scrophularineæ.

Genus 7. **Veronica**, Linn.

1. *V. darwiniana*, sp. nov.

A small neat glabrous shrub, with short spreading opposite simple branchlets, their bark light-brownish-green, with a narrow longitudinal pubescent line decurrent from bases of each pair of leaves to the next pair. Leaves subdecussate, distant, regular, subconcave, thickish, glaucous-green, minutely and thickly dotted with whitish specks on both surfaces, broadly-lanceolate, 8–9 lines long, 2½–3 lines broad, not keeled, sessile, tips acute, blunt, margins entire lighter green (or yellowish-green). Flowers subterminal in 2–4 opposite axillary racemes, having a subcorymbose appearance; racemes short sub 1in. long, the flowers very thickly set; peduncle 6–7 lines long, pubescent, as also are pedicels and bracts; pedicels sub 1 line long; bracts ovate acute submembranous, adpressed, longer than pedicel. Calyx glabrous, lobes broadly-ovate, green with white membranaceous margins, tips ciliolate. Corolla white, 3 lines diameter, lobes incurved obtuse, the 3 larger oblong, the upper solitary, the lower lobe very small; tube 1 line long, throat puberulous; anthers largely exserted; purple; style slender, patent, 4 lines long; stigma small, penicillate. Capsule dorsally compressed, 3 times as long as calyx, broadly-ovoid turgid, red-brown, veined; valves 2-fid, gaping; seeds numerous, orbicular and broadly-elliptic, disc form thickest in the middle, light-brown, glabrous, shining.

Hab. On hills in the interior, Hawke's Bay; 1890–92: *W. C.*

Obs. I. A species *primâ facie* near to *V. colensoi*, Hook., but differing in several particulars—as, leaves smaller, subconcave and of another form; flowers pedicelled, bracts thin and longer than pedicels; lobes of calyx thin and ciliolate; corolla lobes very different, with puberulous throat; capsule larger, &c.

II. Named in honour of the illustrious Darwin, who visited New Zealand, with Captain Fitzroy, in H.M.S. "Beagle," in 1835, and with whom I had the honour and pleasure of spending Christmas Day in that year.

2. *V. oligantha*, sp. nov.

Plant small herbaceous slender simple glabrous, suberect and decumbent, 3in.–6in. high, sometimes with a very few small branches, main stems and pedicels closely and finely puberulent. Leaves few rather distant, pale-green, broadly-ovate and broadly-elliptic almost suborbicular, 2½–3½ lines long, 2–2½ lines broad, margins cut-crenate, and those of the upper and calycine leaves finely ciliolate, tips obtuse rounded; midrib below keeled prominent; 3-nerved, largely veined, veins compoundly-anastomosing; petiolate, petioles sub 1 line long. Flowers very few, distant, small, single, axillary in cauline leaves in the upper part of the stem and terminal, usually 3–4 pairs, the lowest pair opposite, the upper ones alternate, pedicelled, pedicels erect stout nearly 2 lines long. Calyx 4-cleft to base, segments oblong, obtuse, 1-nerved, shorter than corolla. Corolla pale, small, 1½ lines long, tube very short scarcely any, segments all rounded the upper one the largest; much veined, veins forked. Stamens long curved; anthers large exserted, orbicular, claret-coloured; style very long, longer than capsule, filiform, persistent; stigma large capitate. Capsule fawn-coloured, sub-reniform-orbicular $\frac{1}{10}$in. broad, compressed, notch shallow with a few erect glandular hairs on upper margin. Seeds very minute, 50 and upwards in each capsule, oblong, thickish, centrally attached, pale-fawn colour.

Hab. Among grasses and other low herbage, banks of streams, edges of woods, south of Dannevirke, County of Waipawa; 1892: *W. C.*

Obs. Another small herbaceous species of this genus to be added to those already lately described by me (Trans. N.Z. Inst., vol. xxiv., pp. 391–393), and, though pretty closely related to them, distinct from all; perhaps *V. macrocalyx* is its nearest ally. This little plant is somewhat striking at first sight from its very pale-green leaves, and also, on examination, from the great regularity of its few flowers 3–4 pairs, of which, how-

ever, only a single corolla may be found on each stem at one time; no doubt owing to the extreme shortness of its tube, which causes it to fall quickly off on the enlargement of its ovary.

Class II. MONOCOTYLEDONS.

Order VII. Liliaceæ.

Genus 3. **Cordyline**, Commerson.

1. *C. hectori*, sp. nov.

Trunk arboreous, simple, erect, from 6ft. to 30ft. high. Leaves numerous erect and spreading all round, linear-lanceolate, 4ft. 10in. long, 6½in. wide at middle, gradually contracted to 4in. wide at 7in. above base, and again expanding to 5½in. at base, acute not acuminate, rather thin for size (chartaceous), somewhat softish (not harsh, as in *Phormium* and in *C. australis*), but very thick at base, closely striated, margins entire, red thin and slightly recurved, glabrous, greenish-purple above with a reddish hue, and glaucous below with red veins; veins very numerous, above 100 on either side of midrib, parallel, slightly and regularly diagonal, extending nearly the whole length of lamina, and of three kinds—viz., (1) stout red prominent shining, distant about ¼in. from each other; (2) smaller and finer, intermediate and reddish; (3) obsolete again intermediate and glaucous; the midrib red glabrous and glossy, very stout and large at base and for some distance above, but decreasing regularly towards apex and there vanishing, striate-veined on the under-surface for two-thirds length from base. Panicle pendulous, obovate, thick compressed, 16in. long and 17in. girth over all; peduncle (or main stem) 4in. long,* thick 3½in. girth; subpanicles (simple racemes) numerous, straight, obfastigiate, imbricate, each 7in. long, linear-acuminate, 2¾in. girth, a single bract at base 1¾in. long, 4 lines wide at base, many-nerved, subulate, acuminate, acute. Flowers very numerous and close together; pedicels stoutish, thickened at top, 2 lines long, with 2 bracteoles on each, the outer one the longer, 3 lines long, sub-linear-ovate, 1-nerved, tip subacute, the inner one broader, irregularly shaped, semi-amplexicaul, apex sometimes retuse, and 2–3-fid, acute, acuminate, very membranous. Perianth small, sub ½in. diameter; segments narrow-oblong, split to base, subequal, much recurved, 3-nerved, nerves prominent. Stamens broad and flat at bases, adhering to lobes one-third of length from base, shorter than style, slightly incurved over ovary; anthers linear-elliptic. Style sub 2 lines long, stout, grooved. Berry globose nearly 2 lines diameter, glabrous,

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* But I have not got the whole of it, only that portion which forms part of the panicle, and where the pedicels with flowers begin.

blue; about 16 seeds in each; seeds black, shining, usually 3-sided, flat on two sides and rounded on the third, but when fewer in number gibbous.

Hab. "On the spurs and in the gullies of the Ruahine, Kaweka, and Kaimanawa Mountain-ranges, County of Hawke's Bay; alt. 2,000ft.–4,000ft. Sometimes growing in the woods, and sometimes in the open lands, but more generally along the edges of woods, and among scattered shrubs."—*Mr. Thomas Hallett, in lit.*, August, 1892.

Obs. I. Mr. Hallett also says in his interesting letter, "These trees vary in height from 6ft. to 30ft., but are generally about 12ft. high in open lands, and 20ft. in woods. The flowering-stem hangs down beside the trunk of the tree. The leaves sent were cut from a tree growing at 2,100ft. alt. above sea-level, and at about 7ft. above ground; there were 60 of them besides the small unfolded central ones; the diameter of the trunk was 6in. Each leaf in falling off leaves a ring on the stem, which becomes very indistinct after a few years; and, as several leaves grow every year, there are many rings formed, so that the age of the plant cannot be determined by them."

II. I have long known this plant—from my *first* seeing it in its native habitat in the '30s, and often afterwards in the '40s, when travelling in the mountainous interior of this North Island, and also in following years occasionally cultivated in gardens*—but had never seen its flowers; and from the description of Forster's plant, *C. indivisa*, obtained by him in the South Island (as given by Hooker), I always had a doubt of it being the same species as this one, which doubt was also further increased through my certain knowledge that Forster had never been in this North Island. And when I read "the valuable communication regarding the *Cordylines*" made by Sir James Hector to Sir Joseph Hooker,† I felt pretty well confirmed in my opinion. Sir James Hector wrote,—

"5. *C. indivisa.* This is the broad-leaved deep-green *ti*, ‡ with red veins, a single head, and long elegant flowers, that Forster found in Dusky Bay. The leaf has a slight resemblance to the true *toii* of Colenso, which has led to the confusion, no doubt.

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* I had for several years fine plants of it growing well in my garden at Waitangi (Hawke's Bay), with other mountain plants, as *Ranunculus insignis*, *Aciphylla colensoi*, *Calceolaria repens*, *Cordyline banksii*, *Anthericum hookeri*, &c. All these flourished and flowered there until a very severe and long-continued flood, which overflowed my garden and deposited a large amount of silt, which destroyed them all.

† "Handbook of the New Zealand Flora," p. 743.

‡ *Ti* is the Maori name for the *Cordylines;* it may be called their generic one.

"6. *C.* sp.? Toii. A large tree, with many heads, and huge broad massive leaves, yellowish, with yellow and red veins, and ponderous inflorescence with long bracts and black shiny seeds. This is the *ti* that the Natives use for mats, &c. The portion of the description of the Handbook which refers to *C. indivisa*, and which you got from Colenso, applies to this plant."

To this Sir J. Hooker adds, "I have no Dusky Bay specimens of Forster's plant, but Colenso's agrees well with Forster's figure in the British Museum" (*loc. cit.*). And in my fully describing this northern species of *Cordyline* I have also, with very great pleasure, named it in honour of our well-known scientific naturalist, Sir James Hector, K.C.M.G., M.D., F.R.S., &c., who had not only seen both species growing in their native habitats in his travels in the North and South Islands of New Zealand, but had at an early date (prior to 1864) called Sir Joseph Hooker's particular attention to their specific differences.

III. From time to time of late years I have made several endeavours to obtain both flowering and fruiting specimens of our northern subalpine *Cordyline*, but have always failed until this present year (1892), when, through Mr. Hallett's kindness and care, I obtained what I had so long sought; I having long known him, and he being a resident settler far away in the hilly interior, and pretty near the home of these plants, and well acquainted with them. To him I feel much indebted for the several packages of specimens in various states he so readily obtained and sent me, though at no small trouble and labour to himself, as well as for his interesting notes and letters concerning the plant. And, not being satisfied with the specific description of *C. indivisa* as given by Hooker, both in his "Flora Novæ-Zelandiæ" and in the Handbook, and not possessing the fifth volume of Kunth's "Enumeration" (though I have vols. 1–4), and finding, on inquiry, the said fifth volume was not here in the colony, I got a kind naturalist friend to write to Berlin to get a verbatim copy made from Kunth's work, and this I received a few months back, which with me settled the question concerning the specific differences of the two plants.

IV. In conclusion, I may observe that several striking *primâ facie* characters in this species here described do not accord with those of *C. indivisa* (*vera*), Kunth: *e.g.*, Sir James Hector mentions its "long elegant flowers" (*loc. cit.*), and Sir Joseph Hooker also calls them "the large flowers," with "its excessively thick and coriaceous leaves" (Handbook, p. 282), which leaves, however, are really smaller, as described by Kunth, who says of them, "2–4 pedes longa, medio 4–5 pollicaris, supra basin 1½–2 poll. lata, rigide, coriacea"; and, further,

the panicle as being much larger—"3–4 pedalis"—with other differences, as "ovula in loculo 5–6," and the plant to be "10–20 pedalis." ("Enum.," v., 30.)

Genus 6. **Arthropodium**, Brown.

1. *A. ramulosum*, sp. nov.

Plant small, slender, glabrous. Leaves 10, prostrate, spreading around stem subrosulate, linear-lanceolate, 9in.–10in. long, 3 lines wide, 3 innermost widest, concave, very acuminate tip acute, base half-clasping, membranaceous, flaccid, somewhat curved or subfalcate, dark-green, much parallel-nerved and striate on under-surface and so the cauline leaves. Stem single, erect, 18in. high, purple, slightly geniculate at nodes, 12-branched, base 1½ lines diameter, apex flowering; branches green, striate, alternate, distant, the lower ones 7in. long, decreasing gradually in size upwards, the uppermost 3½in. long at 4in. from tip of stem, spreading horizontally; the lower branches 2in. apart on stem, the upper ones sub 1in.; no branch at lowest node 1½in. from base, but a simple very long cauline leaf or bract 7in. long; at the lowest node of the basal branch a branchlet 1½in. long 2–3-flowered, and at 2 nodes next above on same branch 2 flowers from each (this peculiarity also occurs at the lowest node of the apical portion); at the base of each branch are 2 leaf-like cauline sessile linear-acuminate bracts, the longer one 5in. long 3 lines wide, with a minute lilac-coloured membranaceous bracteole in the axil between branch and stem (also in the axils of all the branches), 2-nerved, tip acute and bifid. Flowers scattered, generally 12 on the longer branches each ¾in.–½in. apart; pedicels ½in. long, slender, jointed above middle, all bracteolate with long green bracteoles. Perianth small white, segments 2 lines long, narrow-oblong nearly alike, reflexed, each having 3 faint longitudinal medial lines (or nerves) parallel and close, the 3 outer segments stouter margins entire, tips subacute and thickened, the 3 inner very membranous margins slightly denticulate-erose, tips truncate; filaments white shorter than perianth 1½ lines long erect spreading, their upper two-thirds densely hairy bushy throughout, extending close up to anther; hairs white stout, glistening, tips obtuse; anthers small $\frac{1}{24}$in. long, pale, linear; style erect a little longer than anthers; stigma simple, capitate, flat, spreading; ovarium green glabrous scarcely 1 line long rounded-oblong.

Hab. In a rocky spot near Mangatoro, south of Dannevirke, County of Waipawa; 1892: *W. C.*

Obs. I. This is a striking and graceful species, having

affinity with *A. candidum*, Raoul, and *A. reflexum*, Col.,* but widely different from both in habit and in general appearance and in several important characters. Its leaves (both radical and cauline) are larger and differently shaped and coloured (not like common grass leaves); stem much taller and 12-branched; branches very long and patent (and sometimes again branched); flowers smaller with different perianth-segments and anthers. But while the differences are many and great they are difficult to accurately describe in words, though soon apparent on examination and comparison with the above-named two species. This plant is also allied to a New Caledonian one—*A. neocaledonicum*, Baker. It also possesses in a striking degree that peculiar quality I had noticed in *A. reflexum* (*l.c.*), of only one flower (on a branch) opening at one time, and this in early morning, and so remaining until evening, when the perianth falls down, resuming its former position, and closely enwraps the ovarium, as in the other plant.

II. I have only seen this one specimen here described, and the peculiar (almost *unique*) manner of my getting it deserves a brief notice. In June, 1892 (during a long wet winter season), I received a dripping muddy parcel of small ferns and other low herbaceous plants, roots and all, in tufts, as torn up from their low and wet habitat (the friend who sent them was there on a geological visit). It took me some considerable time to wash and clean them, and while so engaged I found a very small unequally semi-fascicled or trilobed root (less than a shilling in circumference), without any traces of leaves, stem, &c., and apparently half-dead: this, however, I kept and planted, and this neat plant has been evolved from it. So I am rewarded.

Art. XLIV.—*A List of* Fungi *recently detected and collected in the Bush District, County of Hawke's Bay; being a Further Contribution to the Indigenous Flora of New Zealand.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

In January last I despatched to the Director of the Royal Botanic Gardens, Kew, London, another lot of *Fungi* that I had gathered at various times during the preceding year in the forest country around Dannevirke. This parcel contained

* Trans. N.Z. Inst., vol. xviii., p. 275.

about two hundred separate packets. The Director, Mr. Thiselton-Dyer, soon put them into the hands of Dr. Cooke, the eminent fungologist, for examination and determination, as he had also done on former occasions.* I have recently received from Kew the list of the same, as kindly named by Dr. Cooke; from which it appears that most of them were duplicates of those I had formerly transmitted, several, however, being better specimens, and also in different states of age and growth. These that are new to our New Zealand flora are here given; few of them I take to be really *species novæ*.

1.† AGARICUS, *Linn.*

A. (Pleurotus) bursæformis, *B.*
A. (Pleurotus) diversipes, *B.*
A. (Pleurotus) sordulentus, *Fr.*
A. (Collybia) laceratus, *Lasch.*
A. (Pluteus) cervinus, *Fr.*
A. (Pholiota) unicolor, *Fr.*
A. (Pholiota) pumilus, *Fr.*
A. (Flammula) vinosus, *Fr.*
A. (Flammula) crociphyllus, *C. and M.*
A. (Flammula) purpureo-nitens, *C. and M.*
A. (Lepiota) imperfect.
A. (Leptoma) æthiops, *Fr.*
A. (Clitocybe) laccatus, *Fr.*
A. (Psathyrella) disseminatus, *Fr.*
A. (Leptonia) placidus, *Fr.*
A. (Stropharia) semiglobatus, *Fr.*

4. MARASMIUS, *Fries.*

M. hematocephalus, *M.*

10. POLYPORUS, *Fries.*

P. isidioides, *B.*

16. STEREUM, *Fries.*

S. amænum, *Kal.*
S. obliquum, *B.*

27. GEASTER, *Micheli.*

G. subiculosum, *C. and M.*

30. LYCOPERDON, *Tournefort.*

L. australe, *B.*
L. perlatum, *Fr.*
L. constellatum.

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* See lists, Trans., N.Z. Inst., vol. xvii., p. 265; vol. xix., p. 301; and vol. xxii., p. 391.

† The numbers attached to the genera are those of the same in the "Handbook of the New Zealand Flora."

50. Æcidium, *Persoon.*

Æ. gallii, *P.*

60. Peziza, *Dill.*

P. campylospora, *B.*

68. Hypocrea, *Fries.*

H. rufa, *Fr.*

73. Nectria, *Fries.*

N. ditissima, *Tul.*

Tremella, *Fries.*

T. fuciformis, *B.*

Trichia, *Hall.*

T. affinis, *R.*

Polystictus.

P. decipiens, *Schw.*
P. hirsutus, *Fr.*
P. drummondii, *B.*

Fomes.

F. zealandicus, *Cke.*
F. annosus, *Fr.*

Poria.

P. nitida, *Fr.*

Actinonema.

A. rosæ, *Fr.*

Patellea.

P. adamsoni, *B.*

Helvella.

H. monachella, *Fr.*

Synchytrium.

S. melicopidis, *C. and M.*

Xerotus.

X. glaucophyllum, *C. and M.*

Art. XLV.—*Memorandum of a few New Species of* Hepaticæ *lately detected in the Seventy-mile Bush District; as kindly determined by Dr. F. Stephani, of Berlin.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

In forwarding to Kew the *Fungi* mentioned in the preceding paper, I also sent a lot of *Hepaticæ* that I had collected at various times and seasons with them. These were put by the Director at Kew into Dr. Stephani's hands for examination and determination, as on a former occasion;* and I have recently received from Kew a list of them (but without description), and also a long enumeration of many others sent with them that have been already described in the "Handbook of the New Zealand Flora," in several volumes of the Transactions of the New Zealand Institute, and also in some modern European works.

The species really new to science are only four, while five others that were known have now been found in New Zealand; there were also a few others that were barren or too imperfect to be named, and many that (according to Dr. Stephani) were very fine and interesting.

Moreover, Dr. Stephani's remarks (of several species)—"There have been two forms sent of very different appearance, the normal one growing in places exposed to sunlight, stout and tough very dark, in a dry state almost black and horny, lobules large; while a common variety growing in dark forests is flaccid quite green, lobules small," &c.—are worthy of being copied here.

I. *Species novæ*:—

Symphyogyna subpetiolata.
Aneura papulosa.
Anthoceros arachnoideus.
Lophocolea erectifolia.

II. Species already known, but hitherto not from New Zealand:—

Metzgeria crassicostata, *St.*
Lepidozia quadrifida, *Ldbg.*
Bazzania mittenii, *St.*
Balantiopsis diplophylla, *Mitt.*
Porella stangeri, *L. et G.*

* See Trans. N.Z. Inst., vol. xxiv., p. 398.

III. Species also in the same lot, already described by me (in the Transactions of the New Zealand Institute), and now confirmed by Dr. Stephani as valid *species novæ* :—

Symphyogyna undulata.
Aneura bipinnatifida.
A. alba.
Fossombronia perpusilla.
Bazzania elegans.
B. nitens.

Also, my *Symphyogyna connivens* has been altered to *Pallavicinia connivens*, St., and my *Zoopsis tenuicaulis* to *Zoopsis leitgebii*, Carr et Pears.—very likely from specimens I had early sent them.

III.—GEOLOGY.

Art. XLVI.—*Artesian-water Prospects at Wanganui.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 11th July, 1892.*]

Having a few days to spare at Easter, I paid a visit to Wanganui. My object was to form an opinion as to the prospect of an artesian water-supply for the town. In company with Mr. A. Atkins, architect, I examined Shakespeare Cliff, Castle Cliff, Landguard, and the area within what is locally known as No. 3 Line as far as Kaitoke Lake. The country extending in a north-west and north direction, as far as the Kai-iwi Stream, and the Kaiwaka stone-quarries on the Wanganui River, were also visited, including the cliffs along the sea-coast towards the mouth of the Kai-iwi. In addition to this formal inspection of the country I have consulted the following papers which bear more or less directly upon the geology of Wanganui and surrounding district:—

(*a.*) "Geology of Wanganui," J. Buchanan, Trans., vol. ii.
(*b.*) "Geology of the Province of Wellington," J. C. Crawford, F.G.S., Trans., vol. ii.
(*c.*) "The Wanganui Tertiaries," C. W. Pearce, Trans., vol. iii.
(*d.*) "The Wanganui System," Professor Hutton, F.G.S., Trans., vol. xviii.
(*e.*) "Geology of Western Part of Wellington Province and Part of Taranaki," James Park, F.G.S., Geological Reports, 1886–87, pp. 30, 31.

Each of the papers named has some reference to the district under notice; and the geological sections that are given by Messrs. Crawford, Park, and Hutton to illustrate their several papers have enabled me to correlate the rocks within a radius of at least twenty miles of the Town of Wanganui towards the east, north, and north-west. Wanganui itself is situated a little east of the 155th degree of east longitude, and a few minutes north of the 40th parallel of south latitude. It stands upon the right bank of the Wanganui River, and about three miles from the sea in a straight line. The district between the town and the sea is made up principally of sand-dunes. At the mouth of the river, on the right bank, shingle-

conglomerates appear, just as they appear at the mouth of the Wairoa River in this district. They pass underneath the sands, as no other shingle is met with along the coast in a westerly direction. Two miles or so beyond the mouth of the river cliffs of blue fossiliferous clays make their appearance, topped by light-brown sands and shingle-conglomerates; and these continue along the coast in an unbroken line nearly as far as the Kai-iwi Stream, at a varying height from 15ft. to 40ft. The clays have a general dip to the south-east at a low angle—of not more than 4° or 5°. Proceeding up the Wanganui River from its mouth, the following points of interest claim attention: (*a*) Landguard, (*b*) Putiki, (*c*) Shakespeare Cliff, (*d*) Kaimatera, (*e*) Upokongoro and Kaiwaiki.

Landguard is on the left bank of the river, almost due east from the freezing-works at Castle Cliff. The rock-sections are well exposed, and they provide a key to the distribution of rocks over the whole of the Wanganui district. Freed, or exclusive, of the blown and moving sands which cover the flats and the hills from Putiki to the sea, the following sequence of rocks in descending order is met with: 1. Pumiceous swamp-clays of a brown or fawn colour. 2. Shingle-conglomerates. 3. Sand and clay interbedded. 4. Fine sands. 5. Pumiceous brown sands and clay. 6. Strong conglomerates. 7. Fossiliferous calcareous sands (many fossils). 8. Thin blue clay-sand bands. This bed is characterized by what may be termed a black-oyster deposit. Mr. Park, in his report, draws attention to the existence of a fault about 5 chains from the extreme west end of Landguard Bluff. This may help to account for the conglomerates exposed at Castle Cliff, as the displacement which took place would bring these beds, which dip at a low angle, to near the sea-level at this place. The Putiki sections, as far as exposed, agree with those seen at Landguard, near the shooting-target. (*c.*) Shakespeare Cliff: This important section is situated a few chains above the bridge leading from Victoria Avenue. The section presents the following sequence, read from above: (1.) Pumiceous swamp-clays of a brown and fawn colour. (2.) Pale-yellow sands and clays. (3.) Shingle-conglomerates. (4.) Fine calcareous sands, crowded with fossils, and passing into indurated shell-bands and lenticular limestone-bands in places. (5.) Blue sandy clays, with many fossils in places. Beds corresponding to 4 are finely exposed in a recently-opened quarry between the cliff and the bridge. Beds 1, 2, 3, are not conformable to 4 and 5; nor, indeed, does there appear to be any conformability between the pumiceous swamp-clays and the two beds immediately succeeding. Proceeding up the River Kaimatera, about eight miles above the bridge, Upokongoro, ten miles, and Kaiwaiki, eighteen miles, are the only other

places of special geological interest. At the two former the exposures show beds younger than the blue sandy clays in Shakespeare Cliff, and corresponding in their main characteristics with the higher beds seen in the hills along the left bank of the river from Wanganui to the sea. At Kaimatera the rocks are made up mostly of grits, gravels, and pumiceous sands, passing into fine powdery pumice in several places. At Upokongoro the rocks are made up of mixed clays, conglomerates, grits, and pumice-sands, and they present in their bedding many varieties of movement during deposition. Between Upokongoro and the Kaiwaiki upper and lower quarries I saw no traces of fossiliferous rocks except in certain sand-beds, which here and there make their appearance. At Kaiwaiki, limestone similar to the Napier upper limestone is being quarried on the right bank, and half a mile or so further up the river similar limestone is found at a much higher level, whilst from 10ft. to 15ft. above water-mark blue sandy clay-beds are exposed, corresponding, apparently, with the Shakespeare Cliff beds, sixteen miles or so lower down the river.

The several important points of vantage enumerated above will make it possible to deduce some facts as to the character of the underlying beds in the vicinity of Wanganui. The oldest rocks that are exposed in the district belong to the blue-sandy-clay series. These are met with, as pointed out above, at Shakespeare Cliff, Landguard, and along the sea-shore between the mouth of the Kai-Iwi Stream and the Wanganui River mouth. No exposure of the blue sandy clays is met with between Shakespeare Cliff and Kaiwaiki, and all the rocks met with between these two places belong—so it appears to me—to the upper beds of the series. The blue clays, with the calcareous sands overlying them, sometimes form, as at Kaiwaiki, lenticular bands of limestone, and in one place they thicken out into a true limestone mass, and resemble the Napier upper limestones, as they appear at what is known as Scandinavian Point. The beds overlying these correspond to the Kidnapper pumice and conglomerate deposits, which, with the Redcliffe conglomerates, form a syncline underneath the Heretaunga Plain. Thus, all the rocks in the vicinity of Wanganui belong to a recent period, and they are the actual equivalents of the beds from which the people of Napier and surrounding district derive their artesian water-supply.

I am not aware of the actual distance between the mouth of the Kai-iwi Stream and the Kaiwaiki quarries, nor of the height above sea-level of the river at the latter place; but from what has been stated it will be readily understood that the slope or inclination of the blue clays from the places named

to the south-east in the direction of Wanganui is small, as the blue clays exposed in the Shakespeare Cliff are not less than 30ft. high, and they are about the same height on the beach between Castle Cliff and Kai-iwi. If we suppose a line running along the top of the blue clays from the Kai-iwi mouth or the coast cliffs to the Kaiwaiki quarries, and another from where the clay-sands terminate on the beach towards Castle Cliff to Shakespeare Cliff, there will be actually represented the old slope or plane of denudation over a given area. On this area calcareous and fossiliferous sands were deposited, such as are now exposed in Shakespeare Cliff and in other places along the left bank of the Wanganui River as far as Landguard. In some places the sands have been denuded, and their places are now occupied by shingle-conglomerates and other succeeding beds such as have already been enumerated as being exposed in the several places along the bank of the river. Now, the area between Shakespeare Cliff and the sea, including the spot on which the Town of Wanganui is built, contains traces that it also was, at a comparatively recent date, capped with shingle-conglomerates and pumiceous swamp-clays. In the direction of St. John's there are shingle-conglomerate beds of great thickness, and they appear to be the remnants of a line of hills that once extended from Aramoho to the coast. Whether the area now covered by dunes and shingle-conglomerates is one of denudation or of depression I do not know; but evidence is in favour of a combination of the two. If the former be the sole cause of the changes, then we may be sure that the blue clays of Shakespeare Cliff are not far below the surface, and artesian water would hardly be expected or possible under such conditions. But if the area under notice is one of depression—that is, if the country between Shakespeare Cliff, Landguard, and the cliffs along the coast in the direction of the Kai-iwi mouth be one of depression—then the conditions exist of a catchment- or water-basin, and the prospects of an artesian water-supply are good. Every deposit covering the hills in the immediate vicinity of the town, and to the north-west and north of the district, is a great water-carrier, except the clay-beds, and the general slope of the beds from the Kai-iwi Stream and the Kaiwaiki quarries is towards Wanganui.

These are essentials to the existence of an artesian water-supply; but there is yet another essential—viz., the existence of a basin or a depression-like area having such an arrangement of beds that water may drain into them, and be focussed, as it were, to a given place, somewhat like the depression for the gravy in a good grill-iron. The lower bed must be impervious, or nearly so, to water, and it must be channelled or troughed somewhat like the blade of a long-handled shovel, as used by navvies. In other words, whilst there may be a

slope of beds in one direction, there must be a tilting along the edges of the beds in the opposite direction, or in the line at right angles to the flow. In the case of the area between Wanganui and the sea, the long-handled shovel referred to above will fully illustrate what is wanted. If the handle of the shovel be placed in the direction of Aramoho, and the blade in a sloping direction towards Redcliffe, then the sides of the blade will represent the cliffs along the sea-coast on the one side and those between Shakespeare Cliff and Landguard on the other. These will tilt inwards, and water dropped on any portion of the blade, or the handle, were it flat, will flow in the direction of Castle Cliff. Now, the clays extending from Shakespeare Cliff to the coast cliffs appear to be so tilted; but whether as a result of denudation only, or of depression, or of a combination of the two, it is—unless the testing-bore be used—impossible to say. That there has been a downthrow along the strike of the beds is certain, for Mr. Park truly points out that "about 5 chains from the extreme west extremity of Landguard a fault extends across the strike of the beds. The gravel-bed which occupies a position up the middle of the cliff is faulted down to the water-level, the displacement being about 50ft." This may account for the dip, as seen in the cliffs on the sea-beach, where the conglomerates suddenly dip underneath the sands, and it is certain that similar conglomerates at Castle Cliff dip towards them, as if forming a syncline. Here, then, there is evidence of what appears to be a limited area of depression; but whether the area in the immediate vicinity of Wanganui itself was affected cannot be stated.

These are all the facts which it has been possible to correlate concerning the character and arrangement of the rocks in the vicinity and district around Wanganui. The area of the probable water-bearing basin is a very limited one, and of irregular outline, and great care will be necessary in the selection of a proper site for a trial-bore, should it be decided to put down a well. My own opinion is that two trial-bores should be put down, if any attempt is made at all. A bore put down near the site of the Girls' College, and another one at or near the Asylum, would test the question, once for all, whether or not there is an artesian basin in the vicinity of the town. The depth for testing purposes should not be less than 130ft. or more than 250ft., and, if the area be one of depression, no doubt water will be struck within these limits.

Art. XLVII.—*Artesian Wells, Wanganui, New Zealand.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

Plate XLV.

At the meeting of this society in July last I read a paper on the geology of the Wanganui district, with special reference to the possibility of Wanganui itself being situated within an artesian-water-bearing area. At that time I had no idea that the governing body in Wanganui would so soon act upon the recommendations made by me in a special report made to them; but, the test having been made and success achieved, it is with pleasure that I bring the matter once more under the notice of members.

It will be remembered that a suggestion was made in my paper to the effect that two trial-bores be put down in places indicated on a plan of the district—one of the places being near the Girls' High School, the other one being near the spot marked as the "Asylum." To test the matter, the Wanganui Borough Council decided to put down a trial-bore near the first-named place; and, tenders having been called for, Mr. Gilberd, of Taradale, obtained the contract, and on the 8th of the present month he struck a fine flow of water at a depth of 218ft. The pipe is a 4½in. bore, and the daily flow is estimated at 100,000 gallons, with a pressure of 7½lb. to the square inch, which is equal to a rise of about 14ft. above the surface, when friction is taken into account. At the spot where the well is situated the height above sea-level is 46ft. As the location of the second well appears to be outside the ordinary borough limits, no contract has been made for sinking the second well; but, now that artesian water is known to exist in the district, no doubt those who are interested in obtaining a water-supply at or near the place indicated will not be long in providing themselves with the inestimable boon of unlimited pure water, without which sanitation, according to hygienic laws, is impossible.

The authorities in Wanganui have sent me specimens of the different strata met with during the sinking, and the beautiful section here shown, with the photograph of the well, have been prepared for me by Mr. A. Atkins, F.R.I.B.A., of Wanganui, to whom I am indebted for valuable help during my visit to the town, and who first brought the question of an artesian water-supply for Wanganui to my notice. The

different beds passed through, as shown in the drawing, correspond in many respects to those met with in the Napier-Heretaunga artesian basin; and they are similar in the main to those forming the hills over the whole of the Wanganui district, as far as seen by me. They belong to what is known as the "Kidnapper conglomerate and pumice deposits," which are so largely developed throughout the Hawke's Bay District. From the specimens sent to me it is evident that the area forming the Wanganui artesian basin is one of depression or slow subsidence, similar to our own Heretaunga Plain; and when a few more wells shall have been put down it will be possible to do what it is possible to do now in the case of the Napier and Heretaunga wells—that is, to tell within a very small distance the depth of the sinking necessary to reach the water-bed, no matter where the locality, so long as it is situated within the basin of the water-bearing area.

The following information is given concerning the beds met with in Wanganui well No. 1: (*a*.) 6ft. of black iron-sand, with streaks of orange-red pumice-sands. (*b*.) 6ft. swamp peat and sands. (*c*.) 18ft. pale-brown clay, somewhat tough. (*d*.) 15ft. of fine greyish-blue sands. (*e*.) 65ft. of pale-blue clay, mixed in places with very fine sand. In this bed, and at a depth of 75ft. from the surface, a pukatea log 1ft. in diameter was met with. (*f*.) 14ft. of dirty gravel or grit, with bits of wood. The grits are of all colours; and towards the bottom of the bed some of the grits are cemented together. An inexhaustible supply of excellent water was met with in this bed. It rose to within 6ft. of the surface, or to a height of 40ft. above sea-level. (*g*.) 6ft. of fine, crisp, silver-coloured sand (blown). The small black grains seen in this sand resemble pitchstone. (*h*.) 75ft. of blue clay, with shells. The clay is somewhat tough, but fine sand appears in places. (*i*.) Grey sandstone full of shells, all recent, and corresponding to most of the specimens named in my paper (Trans., vol. xxii., 1889, pp. 435–36) as occurring in the Napier wells. Mr. Gilberd, the contractor for the well, tells me that underlying the present water-bearing bed is deep-blue clay; but I am inclined to think he is mistaken in this opinion. The small specimen of clay sent to me as coming from the underlying bed corresponds in every particular with the clay in the 75ft. section; and I think it will be found that the overlying clay will slowly wear away and be brought to the surface, unless the tube-bore be driven to the bed from which the water flows. From the character of the shells, I think it very likely that another grit- and shingle-bed is below, and there is every appearance that water will be obtained from yet another underlying bed. The water now flowing corresponds to the lower middle beds as met with in the Napier 6in. sinkings;

and, should the "Asylum" well be attempted as recommended, it may be found advisable to go down at least 300ft., so as to test this point. From the specimen of the water received it appears to be admirably suited for domestic use, and with a small outlay the people of Wanganui will now be supplied with at least one inestimable blessing—viz., pure water.

The diagram I exhibit (Pl. XLV.) shows in detail the character of the beds, and the locality plan shows the situation of the well, and the height of the several spots where sinkings are proposed.

Art. XLVIII.—*Discovery of Artesian Water-supply, Ruataniwha Plain.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

About five years ago, when portions of the Hawke's Bay District had been suffering from an unusual drought, the question was asked whether there would be any probability of an artesian water-basin on the Ruataniwha Plain. This plain flanks the lower slopes of the Ruahine Range on its eastern side, and for the eastern boundary it has a limestone range which is in reality a portion of the Puketoi Range. The latter range is of considerable interest, because in its turn it is flanked to the eastward by the chalk-marls which are met with in so many places between Te Aute and Waipawa. The head of the Ruataniwha Plain is at the Guavas, and it extends to the south-west for some distance beyond Takapau, where a fan-like shingle-deposit from the Ruahine separates the plain from the valley of the Manawatu River. The length of the valley from north-east to north-west may be set down at twenty miles, and the average width at eight miles.

There is every appearance that at one time the Ruataniwha Plain was directly connected with the Heretaunga Plain, for the beds in the vicinity of each are identical in their structure and arrangement; but at that time the Kidnappers and Te Mahia Peninsula were joined together, and what is now Hawke's Bay was covered with shingle and conglomerates and pumice from the western watershed. A period of subsidence followed, since which time the Heretaunga and Ruataniwha Plains have been formed, by the deposition of new gravel, sands, and *débris*, from which material similar to the Kidnapper conglomerate and pumice beds had been washed, and which now

flank both plains, and afford complete evidence of the sequence of change such as I have described. The hills between Maraekakaho and the Guavas form the dividing-line at the present time between the Heretaunga and Ruataniwha Plains, and if a cutting were made in the hills so as to unite the plains the bedding which would be exposed would be identical with the beds at Redcliffe and the Kidnappers. The whole country between the Guavas and Maraekakaho, and between Havelock, Pakipaki, and the Kidnappers, received its supplies of pumice-shingle, which it has in abundance, from the same source and at the same time; and wherever there are great breaks in the continuity of the beds the causes are due to changes in the land-surface brought about by earthquakes and earth-movement. The beds flanking the limestones on the eastern border of the Ruataniwha Plain were formed at the same time, and are a part of the beds which are exposed on the banks of the Tukituki and Waipawa Rivers. And the same remark applies with respect to the beds at Norsewood, for they correspond in every particular with the beds forming the hills between the Guavas and Maraekakaho.

But between these boundaries comes the Ruataniwha Plain, which is covered with more recent deposits, and has been filled up since the subsidence took place with the material that the streams and rivers brought down from the fractured surfaces of the country now forming the Ruahine Mountain-range. From this brief explanation it will be seen that the Ruataniwha Plain, like our own plain, is of comparatively recent origin. Both plains have grown and are growing, but the evidence as to their origin is sufficient to determine the possibility of their containing an underground water-supply. Of the Heretaunga Plain, including the area even within the limits of our own town, we have full proof, and it is through the accumulation of facts such as are available with regard to the water-supply in this district that it is possible to make inferences as to the prospects of finding water in other districts.

Nature carries out her work with precision and regularity. The materials with which the work is carried on may differ, but moving water acting under similar conditions produces similar results everywhere, and this is why it is possible to generalise when dealing with changes brought about by ordinary physical laws. It has been already pointed out that limestones form the higher boundary hills on the eastern side of the plain, and traces of a limestone range are met with in the lower hills towards the Ruahine Range. But the limestones in the latter locality have been partly denuded, and replaced by the Kidnapper beds. Underlying the limestones everywhere are blue clays locally known as "papa," and of course these clays may be looked upon as impervious to

water. The Kidnapper series is formed of many varieties of beds, most of them being highly pervious to water: hence we may assume that some of the beds which have assisted in the filling-up of the Ruataniwha Plain are saturated with water, seeing that wherever flowing water passes over beds at or near their outcrop a large quantity must pass away in the direction of the dip of the beds.

Until sinkings had been made it was impossible to tell the depth of the more recent shingle and *débris* which have been deposited within the Ruataniwha basin; and it was with pleasure that I learnt in the early months of this year that Mr. Harding, of Mount Vernon, had determined to try for artesian water on the plain. The contract was undertaken by Mr. J. Gilberd, who consulted me as to the probable depth it would be necessary to go. He was informed by letter than an artesian flow must not be anticipated before 300ft. had been pierced. During the sinking some valuable experiences were met with, because the beds to be passed through necessarily differed from those within the Heretaunga artesian basin; but, although the difficulties were many, a bed of flowing water was reached when the tube-bore had pierced nearly 300ft. of the heavy shingle-deposits, and at a depth of 316ft. a good flow was obtained, the water rising 16ft. above the surface. During the sinking three watertight dividing-beds separating the shingle-deposits were met with. The first watertight bed commenced at 60ft. and continued to 80ft.; the second one began at 120ft. and was passed at 135ft.; and the third one was met with at 236ft. and was passed at 268ft. These three watertight beds separated three distinct water-basins, for during the first 60ft. of sinking there was an unlimited supply of water which rose to within 6ft. of the top of the pipe, and continued there until the first watertight bed had been pierced. Whilst passing through the 40ft. of shingle which separates the first and second watertight beds, there was still an unlimited supply of water in the pipe; but, curiously, it stood at an average height of 33ft. from the top, and remained at that height until the second watertight bed had been pierced. The water then fell to 60ft. from the surface, and remained constant until the third watertight bed was passed, when the water at once rose to the top of the pipe, and the flow continued to increase in quantity each foot that the pipe was lowered. As the quantity of water obtained at the depth of 316ft. is sufficient for Mr. Harding's requirements the work was stopped, but there is every appearance from the material brought up that the true Kidnapper beds are not far away.

At present the flow is at the rate of 18 gallons a minute, the tube-bore being only 2in. diameter, and telescoped through a 3in. pipe, the latter having bent at 275ft. The rise of water

in the three separate beds is a curious circumstance, and suggests the possibility of the change of dip in portions of the beds from 90ft. to 260ft.; or the lowering of the water in the tube-bore may arise from underground springs. The latter is the more likely reason, as the creek known as the Waipawa-mate rises from several strong springs some distance from the well, and I am aware of several very large springs at a lower level in the plain in the direction of Ashcott Station. The water is very clear and tasteless, and is much softer than the water from the Hawke's Bay wells, but is similar to the Wanganui artesian water.

The value of an artesian supply to the residents on the plain cannot be estimated, and now that the question has been settled the residents of Woodville may look with confidence to the possibility of finding an artesian supply within the limits of the borough.

The diagram I exhibit shows the character of the deposits, and gives information which will be of value to sinkers should other wells be put down.

Well completed the 3rd September, 1892. Situated a mile or so to north-east of Te Ongaonga Township.

ART. XLIX.—*On the Occurrence of Granite and Gneissic Rocks in the King-country.*

By JAMES PARK, F.G.S., Lecturer, Thames School of Mines.

[*Read before the Auckland Institute, 27th June, 1892.*]

THE whole of New Zealand belongs to one great orographical system which forms a line of elevation traversing the Pacific Ocean in a north-east and south-west direction, with a long northern prolongation stretching away to the north-west. But, while parts of one system, the geology of the greater islands is specialised by many important features, among which stands conspicuously the absence in the North Island of the ancient Palæozoic crystalline rocks so widely and typically developed in the Provincial Districts of Otago and Nelson. Their absence has been the subject of many interesting discussions among geologists, and many curious and sometimes ingenious hypotheses have been suggested as to the probable conditions existing in this area in older primary times.

The late Dr. Von Hochstetter, in his lecture on the geology of the Province of Auckland, delivered to the members of the

Auckland Mechanics' Institute on the 24th June, 1859, said, "The first striking characteristic of the geology of this province—and probably of the whole of the Northern Island of New Zealand—is the absence of the primitive plutonic and metamorphic formations, as granite, gneiss, mica-slate, and the like." Sir James Hector, in his "Outlines of New Zealand Geology," observes that schists and metamorphic rocks are unknown in the North Island.

The oldest rocks hitherto known to exist in this Island were certain hard splintery greywackes and slaty shales which form the greater portion of the Tararua, Ruahine, and Kaimanawa Ranges, in the Province of Wellington. The same rocks also occupy smaller isolated areas at Tuhua, Taupiri, and Hunua Ranges, and form the basement rock of the Hauraki Goldfields. In the absence of fossil remains, their age has always been a matter of much uncertainty, but they have generally been placed by geologists in the Carboniferous period, mainly, it would appear, from a lithological likeness to some rocks ascribed to that period on the south side of Cook Strait.

The circumstances which led to the recent interesting discovery of granites and other crystalline rocks in this Island are briefly as follow: Last March Mr. Max von Bernewitz, the well-known assayer to the Bank of New Zealand at the Thames, showed me, in his melting-room, some fragments of rocks which had been forwarded from the King-country by Mr. G. T. Wilkinson, J.P., Government Native Agent, for the estimation of the gold which they were believed to contain. Among the rocks I at once identified examples of true granite and a granitic gneiss, and at the same time expressed some doubt as to their belonging to any part of this Island. Mr. T. L. Murray, the general manager of the bank, who always has shown the keenest appreciation of geological facts and problems, at once placed me in communication with Mr. Wilkinson, with the result that at Easter I visited and examined the locality where the specimens were found, acting upon instructions received from the Hon. the Minister of Mines, by whose permission I am now enabled to place the facts of this important discovery before the society.

On my arrival at Otorohanga I found that the rocks referred to were accidentally discovered by Mr. Charles King while mustering his sheep in the Mangaone Valley. Judging from their great weight and colour, he thought them likely to contain gold; and, aided by Mr. Arthur Ormsby and Mr. Griffiths, of Alexandra—the latter an old alluvial miner—the locality was diligently prospected, and one or two "colours" are said to have been found in the wash in the bed of the Mangaone Stream, while some fragments of granite, which

were rough-crushed and washed by Mr. Griffiths, are also believed to have yielded a speck or two of the precious metal.

The exact locality of the discovery is situated on the left bank of the Mangaone Stream, about a quarter of a mile above its junction with the Turitea River, which rises among the wooded Tapuaea Hills, lying some two miles east of the Hauturu Range, and falls into the Waipa River four miles south of Alexandra.

From Otorohanga southward to the Upper Mokau, and westward to the sources of the Waitomo and Moakurarua Streams, the country is occupied by long, low, undulating or flat-topped ridges and spurs, in most places covered with a dense growth of fern and tutu, with here and there, in sheltered places, isolated clumps of forest vegetation which have survived the general destruction of the great forest which in comparatively recent times covered the whole of the Waipa and Mokau Valleys.

This land, I am informed, still belongs to the natives. It comprises an area probably not far short of 200,000 acres, almost all of which are most desirable for European occupation. It is readily accessible to a constructed railway, and when thrown open to settlement will become one of the richest and most prosperous pastoral districts in the North Island.

These fern-covered hills and ridges are principally composed of soft green and yellowish-coloured calcareous sandstones, interstratified with blue marly crumbling clays, called "papa" by the natives. Both the sandstones and clays contain an abundance of marine shells and corals; and towards their base, where there is an excess of calcareous matter, they pass into a hard limestone, in many places of great purity and of much value for burning into lime for agricultural and building purposes. They are of Cretaceo-tertiary age, and form an important and well-marked series of the coal-measures of New Zealand. In this district, as well as in other places in this central region of this Island, they are distinguished by the presence of valuable seams of superior brown coal, occurring at the base of the formation at the point where it rests on the old denuded floor of the country. It is a noticeable circumstance here, as at Whangarei and Kawakawa, that where the hard semi-crystalline limestone rests on, or approaches, the old rocky floor the coal is usually absent, or represented only by a streak of impure carbonaceous shale. This would tend to show that the limestone and coal were, in part at least, the result of contemporaneous developments of growths, the former on a sea-bottom, the latter on low-lying swampy areas contiguous to the sea.

From the sources of the Waipa the limestone, with the underlying coal-measures, extend southward almost uninterruptedly to Totaro, in the middle Mokau Valley, and westward to Kawhia Harbour and the west coast. On the slopes of Pirongia and the Hauturu Range they are much obscured by a covering of trachyte tuffs and lavas, which occupy all the higher parts of this watershed, and descend in some places to the sea.

In the months of March and April, 1859, Dr. Von Hochstetter explored the valleys of the Waipa, Mangapu, and Upper Mokau. In his narrative of the journey he describes the pumice terraces in the Lower and Upper Waipa Valley, and makes a number of interesting observations relating to the physical and geological features of the country he passed through. The time at his disposal did not permit him to make a close examination of the geological structure of this district, and his route along the course of the Waipa and Mangapu Rivers carried him to the eastward of the rich limestone and papa country already described.

In the month of January, 1885, under the direction of Sir James Hector, I geologically examined the whole of the country lying between Alexandra and the slopes of Pirongia, including the district around Hikurangi and the north end of the Hauturu Range, which was the most southern point I reached on that occasion, on account of the obstruction of the natives. I defined the boundaries of the limestone and associated marly greensands, and examined the coal-outcrops in the Okoka and Moakurarua Valleys. In my report I also described the occurrence of hard argillaceous and siliceous sandstones in the bed of the Ngutunui Stream, at the point where the road to Kawhia begins the ascent of Pirongia.

Proceeding up the banks of the Mangaone Stream from the point where it joins the Turitea River, the rocks first met with are tough, grey, vesicular. trachytes, which were found by a subsequent examination to occupy the narrow ridge dividing this stream from the Maokurarua River, presenting on both sides a long line of steep escarpment varying from 20ft. to 80ft. in height. At a point some 20 chains higher up the trachytes are cut off by the underlying calcareous sandstones, which appear first in the bed and then on the banks of the stream. Still proceeding up the valley, the calcareous sandstones are found tilted to the north-west at a low angle, and are seen to pass downwards into an impure limestone, which in its turn becomes first gritty, then pebbly, and immediately passes into a coarse conglomerate composed principally of large rounded or subangular boulders of granite and hard somewhat flaggy argillaceous sandstone. The granitic element reaches its greatest development a few chains above the impure limestone

in a rounded spur which terminates abruptly at the stream. Beyond this point the granite boulders become fewer, being rapidly replaced by those of the argillaceous sandstone, and in a short distance they disappear altogether.

The section for the next few chains is somewhat obscured by the trachytes which descend from the higher part of the range at this point; but a little higher up, at the falls, the argillaceous sandstones are seen *in situ*, being well exposed in the bed of the stream for a distance of 4 or 5 chains.

At the falls the sandstones alternate with thin beds of hard crumbling clays or mud-stones, and often exhibit a tendency to weather in rounded concretions consisting of thin radiating concentric layers enclosing a hard nucleus. At a place about 4 chains above the falls they contain a thin irregular streak of fine bituminous coal, and I noticed that here the sandstones themselves were finely micaceous. They strike N.–S. (magnetic), and dip west at an angle of 45deg. Higher up the valley the coal-measures wrap over the outcrop of the older sandstones and close the section in that direction.

[A sketch was here included, showing the position and probable relation of the rocks met with in the line of section just described, extending from the mouth of the Mangaone to the falls.]

Returning to the conglomerate, a close examination showed that the fragments of granite and sandstone were mostly well water-worn, rounded or subangular, but large angular blocks of granite, sometimes over 1ft. in diameter, were found in the bed of the stream below the outcrop of the conglomerate, and pointed to the proximity of the granite *in situ*. A collection of rocks composing the granite comprised, besides the hard flaggy sandstones, granites of all degrees of texture, granitic and hornblendic gneiss, greisen, and quartzite.

Among the granites, the typical fine-grained grey variety was well represented, but the predominating crystalline rock was a coarse-grained, dark-grey-coloured granite, in which the muscovite was replaced by biotite. The felspar was in most cases well developed, and in some examples possessed a light flesh-colour.

In the granitic gneiss the laminated structure of the constituent minerals was often well exhibited, even in hand-specimens, and when the mica was biotite, as was frequently the case, the rock possessed the characteristic schistose structure of a true gneiss. The hornblende gneiss is composed principally of hornblende and orthoclase, and might perhaps be more accurately defined as a syenitic gneiss. It possesses a most remarkable likeness to the hornblende-gneiss rocks associated with the Lower Silurian rocks of the Mount Arthur and Pikikiruna Ranges in Collingwood. They are not

common in the conglomerate, but, like the granites, they are found in varieties of all degrees of texture. The colour of the hornblende is dark bottle-green, and of the felspar white or grey. In the finer-grained varieties these minerals exist in about equal proportions, giving the appearance of a black rock speckled with white. In the coarser varieties the hornblende predominates, and occurs in large irregular masses, enclosing comparatively large confused crystals of orthoclase.

No fossils were found in the conglomerate, but the pebbly limestone immediately overlying it contains numerous marine forms, chiefly corals, mixed with small angular fragments of sandstone, granite, and quartzite. The sandstone, which was found *in sitû* at the falls, has all the characteristics of the Jurassic sandstones at Kawhia. Its presence as large and small blocks in the granite conglomerate proves conclusively that the conglomerate belongs to a later formation, while the small angular pieces of granite and sandstone contained in the pebbly beds overlying the conglomerate also prove that these beds are younger than the conglomerate. From these facts it may be inferred that the materials forming the conglomerate accumulated on a broken rocky shore-line, being the detritus derived by a Cretaceous torrent from the erosion and destruction of a wide land-area, of which no trace now remains. The former existence of a large land-surface in this region, composed principally of granites and other crystalline rocks, fringed by a mantle of Middle and Lower Secondary rocks, and subject to the erosion of rivers with great transporting-power, is conclusively established by the presence and composition of the conglomerate. The probable direction of the extension of this old submerged continent is not so easy to determine. It is perhaps permissible to suppose that a floor of granite and granitoid rocks extends eastwards throughout the central portion of this Island and westward towards Kawhia.

In his report on Kawhia district, Mr. A. McKay mentions the occurrence of a syenite conglomerate on the south side of the harbour. Whether the syenites possess a trachytic or granitic character is not stated, and, as the rock called for little comment, it may be judged to present nothing uncommon or remarkable. In view of the present discovery of granites in the Waipa Valley, it would be interesting to know if there were any indications of these rocks in the Kawhia conglomerates.

Granites are often of an eruptive character, and in Scotland are said to have been found of Tertiary age penetrating Jurassic strata. In New Zealand no granites younger than Silurian are known to exist, and, as those in the Mangaone conglomerate, as well as the associated gneiss and quartzite

rocks, bear so striking a resemblance to the crystalline rocks of the Pikikiruna Range and many parts of Collingwood, there can be little hesitation in placing them as Silurian.

Hitherto no granites or ancient crystalline rocks of any kind have been known to exist in the North Island, and this may be regarded as one of the most important geological discoveries of the last thirty years. The discovery is not only unique and interesting from a geological and scientific view, but it also possesses an important bearing of an economic kind. Granite and gneiss are well known as the bearers of metalliferous deposits, more especially of those of tin, silver, and copper, and it is possible that the exploration of the broken country lying west of the Hauturu and south of Kawhia Harbour may disclose the presence of valuable ores of these metals.

The central volcanic region of this Island is occupied by a vast development of rhyolites and trachytes, the most highly acidic of recent volcanic rocks. Their ancient prototypes, granite and syenite, are the most acidic of all ancient crystalline eruptive rocks, and it would be interesting to discover if the occurrence of these recent and ancient acidic rocks in the same area was a mere coincidence or the result of the operation of natural agencies.

At the present time there is a great diversity of opinion among geologists as to the probable source or origin of the solid products erupted from volcanic rents and fissures. According to one hypothesis the interior of the earth is occupied by a fiery liquid mass of molten matter surging against the outer shell or crust. Some believe that this molten magma consists of two distinct portions—an upper layer, composed of the lighter and more acidic materials, and a central portion, composed of the more dense and basic materials. This hypothesis was invented to satisfy and explain the supposed discovery of a regular succession in the character of volcanic products, according to which the acidic lavas came first and the basic lavas last.

However this hypothesis may suit the countries where it originated, it certainly will not be possible to reconcile it with the facts relating to the order of the eruption of igneous rocks in New Zealand, as I will presently show in the following statement of the character of the contemporaneous eruptive rocks from the beginning of the geological record up to the present time.

It will be impossible to push our inquiries beyond Silurian times for facts based on actual observations. Nothing whatever is known as to the composition of the first original crust which formed on this incandescent sphere, before geological time began, but its basic character may be inferred from the

great difference between the mean density of the materials forming the accessible portion of the crust of the earth and the mean density of the globe as a celestial body. The oldest sedimentary rocks in New Zealand are certain flagstones, slates, and quartzites forming the core of the Pikikiruna Range, lying between the Motueka and Takaka Valleys, in Nelson. These underlie a vast development of Lower Silurian rocks, and in my report on "The Geology of the County of Collingwood" (Geological Reports, 1888–89) I classified them as Cambrian. They do not appear to have been intruded by contemporaneous igneous outbursts, and therefore supply no information relating to the present inquiry.

In the Silurian period were erupted acidic lavas, forming granites and syenites; in the Devonian period, basic lavas, forming diabases, basalts, and ultrabasic serpentines and peridots; and in the Carboniferous period, acidic lavas, forming syenites. From the Permian period, through the whole of the Secondary formations up to Eocene times, there appears to have been a general cessation of volcanic activity in the New Zealand area. After this long period of quiescence, volcanic energy of a most violent, devastating, and widespread nature manifested itself towards the close of the Eocene formation. There is abundant evidence to show that this sudden display of pent-up energy was accompanied by severe and prolonged earthquakes, causing the formation of deep fissures and great faults. The faults which originated at this time were numerous and deep-seated, and caused many permanent modifications in the physical features of the country. At the Port Hills, Nelson; at Shakspeare Bay, Picton; along the whole course of the Inland Kaikoura Mountains; at Lake Wakatipu; at Martin's Bay and Big Bay, on the west coast of Otago; and at many other places in New Zealand, hundreds of feet of strata have been involved among old Palæozoic rocks by great faults, some of which have established themselves along lines of weakness along which displacements have taken place at intervals up to the present time. It was probably at this period of eruption that the great continental area which was supposed by Hochstetter to have existed off the west coast, and of whose existence proofs are not wanting, became finally submerged in the Pacific Ocean. At this later Eocene period were doubtless erupted the great series of auriferous pyroclastic tuffs and andesites of the Hauraki Goldfields, and also the basic and semibasic lavas and tuffs at Banks Peninsula, Oamaru, and Port Chalmers.

The next grand outburst of volcanic activity took place in Pliocene times, and converted the central portion of this Island into one vast theatre of volcanoes, discharging showers

of frothy pumice and dust, and streams of liquid rhyolitic lava. This display culminated in later Pliocene ages in the formation of the massive mountains Ruapehu and Tongariro, the graceful Egmont, the table-topped Horohoro, and the ridge-shaped Tarawera.

The evidences of volcanic activity in more recent times abound on every hand. We have the numerous basic cones of the Auckland isthmus, the semi-basic Ngauruhoe, and the acidic tuffs and muds at Tarawera and Rotomahana.

This record of the igneous eruptions in New Zealand is merely a wide generalisation, but it serves to show that there has been no succession whatever of acidic and basic volcanic products in this area. It could easily be shown that even in recent times both classes have been erupted almost, if not quite, contemporaneously in regions not far separated from each other. It is therefore evident that the theory of the two magmas cannot be applied to New Zealand.

Another and perhaps more admissible theory is that the liquid lavas and solid products which issue from volcanic vents are erupted from large cavities in the solid crust of the earth filled with molten rocks. These huge cavities are generally supposed to exist at no great distance from the surface, and they are believed to have been formed by the contraction of the crust causing irregular crumpling and folding, and consequent entanglement, of portions of the original magma. This hypothesis does not deny the existence of a central liquid magma of a homogeneous character, and it may help us to explain the diversified character of our igneous eruptive rocks.

The elaborate experiments of Fouque, Delesse, Daubree, and others have shown that all the different kinds of igneous rocks with which we are acquainted could be produced by the fusion of existing aqueous or crystalline rocks. If these cavities do exist, whatever the cause of their origin, it is evident that the highly-heated liquid lavas or rocks with which they are filled would fuse the solid rocks in contact with them, and thus largely determine the character of the fiery mass. Where a number of independent cavities existed the nature of the solid materials erupted from them would vary according to the character of the rocks adjacent to them. Where the deep-seated rocks of a district consisted of slates and limestones the fusion of these would form a basic lava, and where sandstones or granites a highly-acid lava. It is well known that some volcanoes have erupted both acidic and basic lavas at different periods of their history, and this might be explained by the internal molten rock being at one time in contact with acidic rocks; at another with basic rocks. It would be interesting to discover that the existence of a great formation of granite,

gneiss, and other crystalline rocks had exercised an influence on the composition of the lavas and other solid products erupted by the volcanoes of the central volcanic region of this Island.

In conclusion, I have to acknowledge my great indebtedness to Mr. G. T. Wilkinson, the Government Agent at Otorohanga, who, although unable himself to accompany me, with much forethought made all necessary arrangements for my guidance and conveyance to the desired locality. To his kindly action in sending the rocks to the Thames on behalf of the native owners of the land are due the circumstances which led to my identification of the granitic rocks; and for this also I have to thank him. I have also to gratefully thank my friends Mr. Charles King and his wife Hana Taare, Mr. Arthur Ormsby, Rawiri te Hauparoa, Horopapera, and Te Kapuranga (the daughter of Hoponi), for their escort to the Turitea, and ready assistance in helping me to investigate the problem surrounding the rare occurrence of granitoid rocks in that locality.

Art. L.—*The Earthquake of the 4th December, 1891: Notes thereon.*

By George Hogben, M.A.

[*Read before the Philosophical Institute of Canterbury, 2nd June, 1892.*]

Plate XLVI.

During last year (1891), Dr. Lemon, Superintendent of Posts and Telegraphs, kindly made special efforts to obtain for me from a number of stations round Cook Strait exact records of earthquake-shocks. The first fruit of those efforts was the attempt in a previous paper to find the origin of a small earthquake on the 5th July, 1891. The facts of the earthquake now under discussion are, however, considerable enough to deserve a somewhat fuller treatment. It will be seen that the data are still insufficient to determine the depth of the origin, for the estimate of the depth given below can only be regarded as very rough indeed. I think we are justified in saying that we now know the position of one of the chief sources of the Cook Strait shocks.

Place.	Time: N.Z. M.T. *Verified.	Apparent Direction.	Apparent Duration.	Effects. Remarks.	Intensity. Rossi-Forel Scale in Roman Numbers.
	A. M.				
(*a*) Otaki ..	4.39*	E. to W.	30–35 secs.	Crockery broken. Preceded by heavy rumbling noise ..	"Severe." vii.
Picton ..	4.40*	N. to S.	20 secs.	Windows rattled; sash-weights swayed to and fro for 1 min. afterwards; houses shaken severely. Preceded by loud rumble	"Severe." iv. to v.
Havelock ..	4.40*	N.W.	5 secs.	..	"Severe." iii. or iv.
Foxton ..	4.40*	S.E. to N.W.	20 secs.	Articles thrown off mantelpieces; clocks stopped; small amount of crockery broken	"Sharp." vii.
Marton ..	4.40*	N. and S.	12 secs.	Articles rattled. Two shocks—first slight; second much sharper	"Sharp." iv.
Wanganui ..	4.40½*	N.E. to S.W.	50 secs.	Prolonged continuous shock; shaking of utensils ..	"Sharp." iv. to v.
Blenheim ..	4.41*	W. to E.	20 secs.	Subsequent tremors for nearly 30 secs.	"Sharp." iii. to iv.
Feilding ..	4.42*	..	30 secs.	No effects, though shock most severe since 1881. Loud rumbling. Cattle alarmed for 10 min. previously	"Severe." iv. (or v.).
Opunake ..	4.43*	S.E. to N. W	10 secs.	Slight rumbling. Prolonged tremor, with 4 or 5 shocks at intervals. Building creaked. "Woke me up." [A slighter shock, 2 secs., S. to N., at 4 48.]	v.
(*b*) White's Bay ..	4.38*	N. to S.	5 & 2 secs.	Previous rumble for about 25 secs. *Two shocks* ..	"Very sharp." iii. to iv.
Palmerston N.	4.38*	N. to S.	20 secs.	Distinct previous rumbling	"Sharp." iii. to iv.
Woodville ..	4.40*	E. to W., then N.E. to S.W.	over 1 min.	Crockery jingled. A noise described as "a loud explosion" woke many. Severe shake, and prolonged tremor	"Severe." v. to vi.
Upper Hutt ..	4.41*	N. to S.	..	Clock stopped. Previous rumbling and tremors ..	"Sharp." v. or vi.
(*c*) Wellington ..	4.40	E. to W. (?)	about 10 secs.	Accompanied by rumble. Basin and jug, and mirror in door quivered. "Nearly vertical" (?)	"Severe." iv.
Masterton ..	4.42½	W. to E.	nearly 1 min.	Two chimneys injured so as to require rebuilding. Observer awakened. Tremor lasted some seconds after	"Severe." v. to vi.
(*d*) New Plymouth	4.45	N.E. to S.W.	30 secs.	Rumbling and rattling of window-frames	"Slight." iv. (or iii.).
Nelson ..	4.45(?)	E. to W.	a few secs.	Very long and undulating	"Slight." iii.
Westport ..	about 4.40 (?)	..	2 min.	Windows rattled and buildings shook considerably. Not every one awakened	"Severe." iv. to v.

Of these times, I first rejected (*c*) and (*d*), which are not stated to have been verified by New Zealand mean time; but Wellington is probably a good record, being due to Dr. Lemon himself; and the Masterton time seems to have been carefully noted (by one who habitually keeps Wellington time), though not subsequently verified.

All trials show the Upper Hutt time to be too late. Perhaps the velocity of propagation was retarded locally, or, as the previous tremors might suggest, the time was taken at a later stage of the earthquake than elsewhere.

White's Bay, Palmerston North, and Woodville are all two to two and a half minutes at least too early, and possibly refer to an earlier shock.*

We must rely, therefore, principally on the times of the nine places in (*a*). Comparison with the result of the normal equations, indeed, shows Marton and Blenheim to be of less value than the rest, but we are not warranted, *primâ facie*, in excluding them from our calculations.

Four methods were used in finding the origin, depending on the direction, time, and intensity.

Direction.—Drawing lines in the directions given, and at right angles thereto, to include cases in which the direction given is that of the transverse vibrations (see Trans. N.Z. Institute, vol. xxiii., p. 474), we find that we can describe a circle of 15 miles radius with centre D (55 miles from Wellington, 58 miles from Wanganui), an origin within which would agree with Wanganui, Otaki, Palmerston North, Picton, Blenheim, Woodville, White's Bay, Havelock, and very nearly with one or two others.

Time: Method of Circles.—Using the times for Havelock, Blenheim, Otaki, Wanganui, and Opunake, with a velocity of 11½ miles per minute, we find an epicentrum E, 49 miles from Wellington, 60 miles from Wanganui. This, however, does not agree with several of the other times, which are presumably equally good. E′, found by the same method from Havelock, Otaki, Foxton, Feilding, Wanganui, Opunake, with an assumed surface-velocity of 8 miles per minute, gives far more satisfactory results.

Method of Equations.—Taking Opunake as the origin of co-ordinates, and the line Opunake–Havelock as the axis of x (Milne's "Earthquakes," p. 206), using all the data contained in (*a*), and forming the normal equations, we get—

---

* A shock taking place at 4.28½ at an origin below some point in the smaller circle shown on the map, propagated with a velocity of about seven miles per minute, would reach these three places at the times named, and thus explain the discrepancy completely. In several of the memoranda forwarded by the telegraph officers mention is made of previous rumbling or tremors (see especially Feilding).

$$
\begin{array}{lrrrrr}
x), & 279{,}268x+ & 93{,}020y+ & 10{,}877u- & 3{,}675w= & 19{,}801{,}880 \\
y), & 93{,}020x+ & 121{,}252y+ & 6{,}379u- & 2{,}119w= & 7{,}979{,}392 \\
u), & 10{,}877x+ & 6{,}379y+ & 636u- & 197w= & 785{,}488 \\
w), & 3{,}675x+ & 2{,}119y+ & 197u- & 63w= & 268{,}104
\end{array}
$$

Hence $x = 74{\cdot}46$ miles, $y = 24{\cdot}55$ miles. K (see Pl. XLVI.) is the epicentrum thus found. It is 56½ miles from Wellington, 59 miles from Wanganui. The equations do not give the absolute velocity (u is negative), or the depth of the centrum. By a method of trial we find the former to be about 7·7 miles per minute, and the latter probably a little less than 10 miles. K is 3 miles north-east of E′.

The absolute velocity, with the same depth of origin, but with the epicentrum E′, would be 8·4 miles per minute. These are both very slow, especially considering the marked (though not severe) character of the shock. The following table shows how these two solutions agree with the best of the recorded times:—

Place.		Time at Origin K. (Mean absolute velocity, 7 7 miles per minute. Depth, 10 miles.)		Time at Origin E′. (Mean absolute velocity, 8 4 miles per minute. Depth, 10 miles.)
Otaki	gives	4h. 32·8min.	and	4h. 33·2min.
Picton	„	4h. 32·9min.	„	4h. 33·8min.
Havelock	„	4h. 32·2min.	„	4h. 33·1min.
Foxton	„	4h. 32·9min.	„	4h. 33·2min.
Wanganui	„	4h. 32·7min.	„	4h. 33·1min.
(Blenheim	„	4h. 31·4min.	„	4h. 32·5min.)
Feilding	„	4h. 32·7min.	„	4h. 33·1min.
Opunake	„	4h. 32·7min.	„	4h. 33·4min.
(Wellington	„	4h. 32·6min.	„	4h. 33·3min.)
(Masterton	„	4h. 32·4min.	„	4h. 33·1min.)
Mean*		4h. 32·7min.		4h. 33·2min.

The time at the origin should be the same from whatever place we reckon back; the close agreement, however, is worthy of note.

Intensity: Method of Isoseismals.—The intensity on the Rossi-Forel scale is indicated by Roman numbers in the last column. If we trace the isoseismal corresponding to intensity iv., and smooth it out into an ellipse, we shall obtain for the focus of the latter one of the points I, S, S′, S″, according to the prominence given to the estimate of the intensity at different places. S′ and S″ are too far to the east, for Foxton and Otaki must be both on or nearly on the isoseismal VII., an ellipse with the same origin as focus. None of the points S, S′, S″ agree with the times. The focus I may be said to confirm in a general way the position already found for the origin.

* Excluding Blenheim, Wellington, Masterton.

The limits within which the epicentrum must almost certainly lie are shown by the inner circle, of 6 miles radius, containing all the points D, E, E', K, and I. The epicentrum of the earthquake of the 5th July, 1891, was estimated to be at A, which is 4 miles S.E. of the last-named circle.

F is the position assigned approximately to the epicentrum of the earthquake of the 20th February, 1890. (Trans. Aus. Assoc. Adv. Sc., 1891, p. 46, and map.)

The line HM is that marked as a probable continuation of the line of fault No. 5 in the map of New Zealand, showing faults and earthquake-rents, published in 1890 by Sir James Hector and Mr. A. McKay.

The small figures on Plate XLVI. to the S.W. of E' show the soundings: it will be seen that there is a marked hollow in the sea-bed in the neighbourhood in question.

It may be as well to note the last two facts referred to, though I do not propose to discuss their significance at present.

The depth of the origin may have been even greater than 10 miles (though that depth agrees most closely with the observed times), for the shock was not stopped by the mountains; for the same reason it could hardly have been very shallow.

Though we are not called upon to explain all the inconsistencies even of professedly good observations, yet the following hypothesis of the movements that took place removes most of the discrepancies, and is supported by the remarks in the fifth column of the table:—

I. A shock, noted at White's Bay and Palmerston North, occurring 3 or 4 minutes before II.

II. The chief shock, lasting nearly 1 minute, with three chief maxima, viz.:—

(α.) First maximum, observed at Marton (so-called "first shock"), Blenheim, and New Plymouth (?).

(β.) Greatest maximum, observed at Wellington, Masterton, Feilding, Havelock, Picton, Otaki, Foxton, Wanganui, Opunake (4.43), and Marton ("second shock").

(γ.) A lower maximum (still considerable), Upper Hutt.

III. A third shock, less severe than I. and II., 5 minutes later than II.—Opunake (4.48); and possibly Nelson (4.45).

The only records remaining unexplained would, if we accept this hypothesis of the history of the earthquake, be Westport, which is evidently rough. (New Plymouth and Nelson may be only approximate also, but admit of explanation as above.)

Summary.—The origin of the earthquake felt around Cook Strait on the 4th December, 1891, was beneath an area most probably including E′ and K′, at a depth possibly somewhat less than 10 miles; the velocity of propagation was slow—about 708ft. per second; the time, at the origin, of the chief shock was 4h. 33min. a.m., nearly; the maximum recorded intensity, vii. on the Rossi-Forel scale.*

ART. LI.—*On an Olivine-andesite of Banks Peninsula.*

By R. SPEIGHT, M.A., B.Sc.

[*Read before the Philosophical Institute of Canterbury, 2nd June, 1892.*]

Plate XLVII.

VARIETIES of this rock are found in several places on Banks Peninsula, either as dykes or as sheets of lava (*vide* "Proceedings of the Royal Society of New South Wales, 1889," page 142), but the particular rock under question occurs on the Port Hills, about three miles from Christchurch. It forms the main part of one of the spurs of the hills which stretch out into the plain in a north-westerly direction. As there are no clear-cut faces, the only place where a good section can be obtained is at a small quarry on the west side of the spur, where stone has been obtained for building parts of the Canterbury Museum and Canterbury College. As this quarry is of small extent it does not give much evidence to determine from a section whether the rock is a dyke or a lava-sheet. There appears nowhere a parting which might mark the wall of a dyke, but there is positive evidence which is almost conclusive that it is a lava-sheet.

1. The size of the spur, which is several hundred yards across, capped all round by this rock, renders it probable that it is not a dyke.

2. The vesicular nature of the rock shows it was a subaërial flow, since, if it had consolidated between the walls of a fissure, vesicles would be absent.

3. The rudely prismatic manner in which the rocks are jointed, with the axes of the prisms vertical and not horizontal, is additional proof that it is not a dyke.

Included in the rock are numerous rounded fragments of a

* The Rossi-Forel scale was adopted as a convenient standard of intensity by the Seismological Committee of the Australasian Association at the Hobart meeting, January, 1892.

hard black andesite. These have consolidated at an earlier period, and have been caught up by the liquid lava as it ascended the pipe of the volcano. These blocks look as if they had been rounded by water, and have almost the appearance of concretions. They are in most cases surrounded by concentric layers of decomposed rock. Probably this is due to the interaction of the fluid lava on the inclusions, and this has produced a rock which has weathered in concentric layers, the junction of the two rocks affording a weak place where atmospheric water might readily promote decomposition.

The rock is of a dark-grey colour, but very often shows a tint of red, which disappears on long exposure to the air, as can be seen in the stone in the buildings above mentioned, where the newer parts can easily be distinguished from the older by the peculiar tint of the stone. The rock is full of cavities and steam-holes, but none of these were noticed to be filled with infiltration products. This rendered an accurate determination of the specific gravity almost impossible. On weighing pieces in distilled water the following results were obtained:—

I., 2·621. II., 2·619. Average, 2·620.

On grinding to a fine powder, and using a specific-gravity bottle, a number of different weighings gave results between 2·67 and 2·68.

The rock appears to the eye to be composed of a glassy or finely crystalline ground-mass in which crystals of felspar are porphyritically distributed. Some of these are over half an inch long, but as they crumble readily it is impossible to detach more than mere fragments for examination. They show at times a fine striation and glistening surfaces, but the cleavage is not well marked.

The examination of the rock was conducted in two ways:—

A. A chemical analysis of the rock as a whole, and of the felspar separately.

B. A microscopic examination by means of thin sections.

A. Chemical Analysis.

Portions of the rock were taken and ground up, so that a perfectly general sample might be obtained, and were analysed a number of times. Since the rock was roughly examined first under the microscope a qualitative chemical analysis was unnecessary. I show all the results obtained, with the exception of those in No. III., as they were completely wrong, from known reasons. The last analysis is the most trustworthy, for reasons which I shall point out:—

	I.	II.	III.	IV.
Loss on ignition ...	2·97	3·16	3·13	3·13
Silica, SiO_2	55·70	54·99	55·10	55·12
Alumina, Al_2O_3 ...	21·10	20·96	...	20·41
Ferrous and ferric oxide	8·47	8·75	...	7·74
Lime, CaO	5·39	5·38	5·38	5·35
Magnesia, MgO ...	1·29	1·45	...	2·75
Soda, Na_2O	3·72	3·94	4·03	3·80
Potash, K_2O	2·66	2·66	2·17	2·50
	101·30	101·29	...	100·80

It will be noticed that the loss on ignition in No. I. is less than in the other cases. This was due to the fact that the mineral was heated in an open crucible, and so the iron present in the ferrous state was oxidized to the ferric state; in the succeeding analysis the powdered rock was heated in a closed crucible, so that there might be no oxidization. After determination of the loss on ignition, the mineral was fused with fusion-mixture, and on extraction with HCl the silica was determined. The result obtained was high in the first case, owing to an error in weighing, care not being taken to prevent absorption of water during the process; but in the succeeding cases this was provided for.

The alumina and iron-oxide were determined by precipitation with ammonic hydrate, and reckoned as Al_2O_3 and Fe_2O_3, and the amount of iron present was determined from another part of the solution by titration with permanganate of potash. This was reckoned as ferric oxide, and subtracted from the combined weight of the Al_2O_3 and Fe_2O_3. This gave the Al_2O_3, and the iron was estimated as ferrous oxide, since on testing with sulphocyanate of ammonia only a very faint coloration was obtained in a part of the original solution. Some Fe_2O_3 was undoubtedly present, as microscopic examination showed. It will be noticed that in analysis No. I. the amount of the Al_2O_3 and FeO is high. This was due to the fact that insufficient ammonic chloride was added, and the magnesia came down with it. This made the reading for magnesia low. It will be noticed in No. IV. that the alumina is lower and the magnesia higher. In estimating the FeO by titration in the first cases the ordinary decinormal solution of permanganate was used, and, on account of the small quantity of iron present in the solution tested, the readings were not sufficiently accurate. In the last determination the permanganate was diluted to a known amount, and greater accuracy obtained. The lime was precipitated with ammonic oxalate, and estimated as oxide.

The magnesia was precipitated with sodic phosphate and

estimated as pyrophosphate. The variation in the results obtained in this case has been explained.

The alkalies were determined by the Lawrence-Smith method, and were determined separately, by titration with silver-nitrate in the first two cases, and by precipitation with platinic chloride in the last two.

The presence of manganese and phosphorus was also tested for, but with no result. The absence of the last would show that apatite was absent.

For reasons given above, it will be seen that the last analysis is the most trustworthy.

The porphyritic felspar was analysed separately, but I will give the results when treating of it microscopically.

B. Microscopical Examination.

Sections of the rock were made by grinding down thin fragments till they were semi-transparent, care being taken to get specimens from rock which was weathered as little as possible. These were examined under the microscope by means of polarised light. The rock then appeared to consist of a semi-crystalline ground-mass in which crystals of plagioclase, augite, and olivine were porphyritically distributed. All through the rock were traces of weathering, as limonite showed nearly everywhere in the ground-mass.

I. Ground-mass.

The ground-mass was semi-crystalline, but the amount of interstitial glass was comparatively small, nearly the whole of the space between the felspar and olivine being taken up with an interlacing network of felspar microliths. These were probably oligoclase, as in almost every case the direction of the extinction was nearly in a line with the length of the microlith; but, on attempting to determine what kind of felspar it was, by means of the extinction of twin lamellæ, results were obtained not at all in agreement with this. In some cases the angle of extinction was so high as to make it anorthite. Besides, in many cases, the microliths exhibited undulose extinction, and the determination of the true angle was impossible. Since the occurrence of a more basic felspar than the porphyritic felspar (I shall afterwards show that this is labradorite) is unusual, I conclude that the majority of the felspar is oligoclase, as determined by the first method.

In some cases the amount of glass was so very small that it hardly appeared in the section at all, but in other cases it occupied a, comparatively speaking, large space. It was full of crystallites, which had no effect on the polarised light. The glass, besides, was coloured brown, owing to the presence of

small quantities of limonite, evidently due to the action of atmospheric agencies or percolating water.

II. PORPHYRITIC MINERALS.

1. FELSPAR.—This is by far the most prominent porphyritic mineral, as it can easily be distinguished by the naked eye, while the other minerals can only be distinguished microscopically. It is of all sizes, from almost microscopic dimensions to crystals half an inch in length. The felspar is almost wholly labradorite, but oligoclase is present to a small amount. The evidence for the species of felspar is as follows :—

(i.) *Chemical Analysis.*

Portions of the rock were taken and broken in order to obtain pieces of the felspar. These were tested chemically,—

(*a.*) With the flame, showing well-marked calcium, obscuring the sodium to a certain extent, but a trace of potassium appeared when the flame was observed through blue glass.

(*b.*) The presence of CaO was shown by precipitation with ammonium oxalate, when a decided precipitate appeared.

(*c.*) By the action of strong hydrochloric acid the mineral was partly dissolved.

(*d.*) By quantitative analysis the following results were obtained :—

	I.	II.
Loss on ignition	...	...
Silica	55·3	55·3
Alumina	26·8	26·3
Ferric oxide	1·8	1·8
Lime	12·5	11·4
Soda	5·5	5·3
Potash	Trace	Trace
	101·9	100·1

The amount of ferric oxide is probably accounted for by the presence of minute inclusions of limonite.

The large value of the CaO in No. I. is probably due to incorrect weighing, as the calcium was estimated as CaO after ignition. As this analysis was almost qualitative, extreme care was not taken. The second determination is probably exact. All the alkali present was estimated as soda, since the flame-test gave such a slight amount of potash. By this analysis the felspar appears to be labradorite, but the amount of CaO is slightly too low for a typical specimen. This may be due to the presence of a small quantity of oligoclase, which subsequent determination shows to be present.

(ii.) *Determination of Specific Gravity.*

The specific gravity was determined by crushing up fragments of the felspar and weighing them in a specific-gravity bottle. The result obtained on several trials was 2·719. This is slightly too high for a typical labradorite, but the inclusions of limonite may contribute to this.

(iii.) *By Optical Methods.*

a. By determination of the angles of extinction of adjacent twin lamellæ when they extinguish symmetrically about the brachypinacoid. The following is a series of determinations:—

1. 173° — 156° — 121°
   17° + 35° = 52°
2. 47° — 79° — 109°
   32° + 30° = 62°
3. 135° — 118° — 108°
   17° + 10° = 27°
4. 51° — 71° — 98°
   20° + 27° = 47°
5. 50° — 77° — 103°
   27° + 26° = 53°
6. 61° — 96° — 124°
   35° + 28° = 63°
7. 53° — 69° — 83°
   16° + 14° = 30°
8. 25° — 48° — 72°
   23° + 24° = 47°
9. 159° — 145° — 130°
   14° + 15° = 29°
10. 135° — 114° — 84°
    21° + 30° = 51°
11. 43° — 61° — 76°
    18° + 15° = 33°
12. 103° — 135° — 163°
    32° + 28° = 60°

The results given show that the angle of extinction extends from 0° up to 63°. This corresponds almost exactly with what is required for labradorite. There may be other species of felspar present, but the great number that are above 37°, which is the maximum angle for oligoclase, shows that the greater proportion must be labradorite. Anorthite may be present, but the other determinations show that it is scarcely possible.

β. By Examination of Cleavage-flakes.—Since the crystals of plagioclase were not large, the only way to obtain cleavage-flakes was by breaking the rock up and looking over the crushed fragments. The following which were obtained furnish further evidence. They were examined by convergent light and also with ordinary polarised light, to determine the extinction-angles :—

(1.) From the brachypinacoid. In convergent light gave an axis just out of the field, with a revolving axial shadow. Angle of extinction $-9°$.

(2.) Also from the brachypinacoid. Gave results similar to (1), but the angle of extinction was $-4°$.

(3.) From the basal pinacoid. Gave an axial shadow and optic axis just out of the field. Angle of extinction was $-5°$.

In this cleavage-flake the twin lamination appeared as alternate bands, but one set were so fine that they became mere striæ, while the other were broad. This gave an interference figure produced from the broad bands, and also afforded a definite line for determination of the extinction-angle. In the other cases this line was not so satisfactory, as straight edges, which were taken to be lines of cleavage, were used.

(4.) From the brachypinacoid. This gave an interference figure in which an oblique bisectrix was clearly visible. The shape of the figure showed it to be oligoclase. In parallel polarised light the angle of extinction was 18°.

The felspar has thus been almost conclusively shown to be labradorite, with the occasional occurrence of oligoclase. It is marked with well-defined polysynthetic twinning. Some of the bands are extremely delicate, while in some cases binary twins were noticed.

A well-defined zonal structure appeared in many crystals. This may be due to successive accretion under different conditions of temperature and pressure, or it may be produced by strain. There is positive evidence that the rock has suffered strain. A large number of felspar crystals show undulose extinction, and this has been shown to be common to the ground-mass as well. In one section a small vein of rock occurred about $\frac{1}{16}$in. long. It was composed of crushed fragments of labradorite, and some of these showed twinning, but others only a delicate striation, so fine as hardly to be noticed. This may be evidence that polysynthetic twinning is due to pressure, as we are led to believe from experiment. This vein was produced during the process of cooling, when the rock had almost consolidated. In another case a crystal exhibited a fine striation perpendicular to the general banding. This was perhaps a twin on the pericline type, but the marking was very faint.

In one of the felspar crystals a remarkable structure was observed. What appeared to be an ordinary narrow band was crossed at small intervals by black marks, so that the whole appearance was like the rungs of a ladder. On examining it with a higher power no difference was observed in the structure. The bars were black throughout the revolution of the stage, whether the nicols were crossed or not, so that it was probably some alteration product produced in a rather curious way. (See Pl. XLVII., fig. i.)

2. Olivine.—The olivine occurs in rounded crystals, which are crossed by irregular cracks. Some of these are so much corroded that they show no trace of their original form (see Pl. XLVII., figs. iii., iv., and v.); but in a few cases faces were seen remaining, as in fig. iv., in which the extinction bisected the angle between the straight edges. The alteration which marks nearly all the olivine present is most strongly observed near the periphery and along the cracks. The alteration product is limonite. It is shown in the figures by the dark shading. Sometimes unaltered fragments are seen, and they show the brilliant polarisation colours and rough surface of olivine. Considering the amount of olivine which has been present, the percentage of magnesia (2·75) is rather low, but nearly all the magnesia has been taken away by weathering action, and there is left an aggregate of limonite.

3. Augite.—The amount of augite in this rock is very small compared with the amount of olivine, and the last-mentioned mineral is the most prominent ferro-magnesian mineral. Only a few crystals of augite were observed in the sections made, and these were a pale greenish-brown by ordinary light. They showed no pleochroism, but moderately brilliant colours under polarised light. They were distinguished from the unaltered olivine by their smooth surface and by the absence of irregular cracks. Some showed a banding, evidently due to polysynthetic twinning (fig. ii.). As this is parallel to $\infty P \frac{\perp}{\infty}$, it gave a means of determination by extinction when an angle of 39° was obtained. In fig. ii. the longer lines represent bandings which also corresponded to cleavage-cracks, while the shorter irregular cracks were parallel to the prism.

4. Magnetite.—The presence of this mineral was shown by examination with reflected light, when numerous black grains appeared, with the blue metallic lustre of magnetite. The presence of this mineral will account for the ferric oxide, which was shown to be present by means of chemical analysis. No other porphyritic minerals were noticed.

General Conclusions.

The description of the mineral constituents of the rock shows that it belongs to the andesite group. However, the large amount of olivine present points to the fact that it ought to be placed in the basic series, if the analysis did not show so large a percentage of silica. This renders it necessary that it shall be classed as an intermediate rock. Since the amount of olivine is so large, while the augite is comparatively scarce, it ought to be called an olivine-andesite rather than an augite-andesite, and it would form a link between the olivine-basalts and the augite-andesites.

Art. LII.—*On a Diatom Deposit near Pakaraka, Bay of Islands, Auckland.*

By A. McKay, F.G.S.

[*Read before the Wellington Philosophical Society, 3rd August, 1892.*]

Two years ago I collected samples of a diatomaceous deposit from the bed of a small lake near Pakaraka, Bay of Islands. On my return to Wellington Mr. Maskell kindly undertook the examination of the samples, which were from the surface, and a foot below the surface, of the deposit.

Mr. Maskell found that in the sample taken a foot below the surface there were forms that did not appear in the surface-deposit, some of which he considered as belonging to extinct forms only found in a fossil state.

Subsequently I read a short paper on the subject, and in that I expressed the opinion that the deposit was not, as suggested by Mr. Maskell, in part the result of the breaking-up of pre-existing beds of diatoms, from which were derived the extinct forms found in the samples examined.

I, on the contrary, favoured the supposition that from the top to the bottom of the deposit the different species of diatoms had lived and died where their remains are now found; and I suggested that were samples obtained from the lower or deeper parts of the deposit other genera might be shown to appear in and be confined to the lower part of the deposit.

Through the kindness of the Hon. Mr. Williams, of Pakaraka, I was again enabled to submit to Mr. Maskell samples taken at intervals of a foot from the surface to the bottom of the deposit, which proved to be 9ft. in thickness.

Mr. Maskell examined five specimen-slides from each of the ten samples taken at a foot apart, and he has favoured me with the following summary of the results obtained:—

DIATOMACEOUS EARTH.—Lake Intermita, Pakaraka, Auckland.

SUMMARY of Observations on *Ten* Samples at each Foot in Depth. (Five Specimens examined of each Sample.)

—	Achnanthes.	Surirella.	Pinnularia.	Epithemia.	Navicula.	Synedra.	Melosira.	Colour.
Nine feet ..	*Very* rare	Several	Several	Several	Plentiful	Several	Very plentiful	White : rather dirty.
Eight feet ..	*Very* rare	Plentiful	Plentiful	Plentiful	Plentiful	Several	Very plentiful	White : rather dirty.
Seven feet ..	Plentiful	None	Very rare	Rare	Plentiful	None	Very plentiful	White : clean.
Six feet ..	Very plentiful	None	None	Rare	Plentiful	None	Very plentiful	White : very clean.
Five feet ..	Very plentiful	None	None	Rare	Plentiful	None	Very plentiful	White.
Four feet ..	Plentiful	None	None	Some	Plentiful	None	Very plentiful	White : very clean.
Three feet ..	Fairly common	None	None	Some	Plentiful	None	Very plentiful	White.
Two feet ..	Rare	None	None	Rare	Plentiful	None	Very plentiful	White : clean.
One foot ..	Plentiful	None	None	Rare	Plentiful	None	Very plentiful	White : very clean.
Surface ..	Very rare—two only seen	None	None	None	Plentiful	None	Very plentiful, and in *filaments*	Green : consistence fluffy.

Melosira forms the principal part of the deposit from all depths.

The disappearance of *Surirella* above eight feet, at which spot it is found in considerable numbers, is peculiar; also, the same may be said of *Pinnularia* and *Synedra*.

Epithemia is practically present in all except the surface deposit.

Achnanthes reaches its greatest frequency at five to six feet. I am not sure whether the two specimens seen in the surface deposit really belong to it.

Navicula (very small) is present all through.

Owing to the absence of intermediate forms connecting the wide distinctions of the different genera, and other reasons, it is evident that no evolutionary process has taken place. The forms present are all well known to students of this branch of natural science. But, while this is so, it is also true that the theory that much of the deposit is derived from an older pre-existing deposit of diatoms is not borne out by Mr. Maskell's last examination. None the less, the results obtained are exceedingly interesting.

I may here point out that the conditions under which, from first to last, the deposit accumulated were unvaryingly the same, there being special provision in the regularity of the intermittence of the supply-waters to this end. Yet, while two genera, *Navicula* and *Melosira,* flourished in predominant numbers throughout the whole period of the deposit, one, *Synedra,* is found only in the first-formed foot of the deposit, but in no great abundance, while three other genera show several specimens at 9ft., are plentiful at 8ft., but in the middle and higher part are absent or rare.

The cause or causes of the disappearance of these forms is a matter respecting which I do not feel warranted in expressing a decided opinion. Nor was this paper written with such a purpose. As stated in the first paper on the subject, further facts were needed in order that the subject might be fairly discussed. It seems to me probable that variations of temperature, not seasonal, but climatic, may account for the gradual or comparatively sudden appearance and disappearance of the four genera not found in all parts of the deposit. Any other theory, it would seem, is either insufficient to account for the facts, or demands too much by way of organic modification or physical change.

IV.—CHEMISTRY.

Art. LIII.—*On the Nature of Stinkstone (Anthraconite).*

By W. Skey.

[*Read before the Wellington Philosophical Society, 15th February, 1893.*]

It has generally, if not always, to this time been supposed that the odour that the rock known as stinkstone evolves when struck or pounded is, as it is termed, bituminous, and that the substance giving rise to this odour, or that of which it is formed, is some kind of bitumen, or a product of it.

Happening, however, to have a specimen of this stone the other day to analyse, I observed that the odour had a great resemblance to that of sulphuretted hydrogen, and upon testing for this gas in the emanations of the pounded stone I found unmistakable evidence of its presence therein.

The stone itself was of a light-grey colour, and was entirely devoid of all bituminous matter. The proportion of organic matter present was only 0·21 per cent. on the stone, and it was of the same character as the organic matter that is usually associated with limestones. Other specimens of stinkstone I analysed for this gas.

From these results I make the general statement that most, if not all, of our so-termed stinkstones contain sulphuretted hydrogen, and that it is this substance, as evolved from it when struck, that gives the odour we observe, and which has been erroneously described as bituminous.

It only remains for me now to inform you of certain interesting results which have been obtained from the experiments that I have made to discover the form in which this compound (HS) exists in the stone.

1. The stone freely evolves sulphuretted hydrogen when simply placed in hydrochloric acid.

2. The stone, ground very fine, and steeped in water for forty-eight hours, still evolved the gas very freely when afterwards placed in hydrochloric acid.

3. The stone, ground very fine, and afterwards subjected to a red heat for two hours, gave a strong reaction of the gas when placed in hydrochloric acid.

4. When ground finely in a very small quantity of water, no sulphuretted hydrogen was found in the water, and the water appeared to be neutral.

5. The gas does not appear to be present in the vapour arising from the stone when heated to temperatures up to a red heat.

These facts appear to demonstrate that this gas (sulphuretted hydrogen) is retained in the stone in the free state, and that at a temperature of about 2,000° F. it is not expelled.

Had there been even a minute trace of it combined with a base, the water in which the stone was pounded would not have been found neutral to test-paper.

That this gas, or that small part of it not oxidized near the surfaces of the particles, adheres to the stone at a red heat is remarkable, and almost goes to prove that it is occluded, and adheres to the stone, in the same way that hydrogen is occluded and retained by red-hot palladium—that is, in some manner dependent upon the exercise of chemical force.

I have only to add here that a stone having all the qualities of stinkstone can be prepared from certain argillaceous limestones containing organic matter, by submitting them to a red heat.

The following is a statement of the composition of the stone upon which my experiments were first performed:—

Analysis.

Carbonate of lime	54·40
Carbonate of magnesia	·93
Iron protoxide	·21
Sulphate of lime	Traces
*Siliceous matter	42·44
Organic matter	·21
Water	·89
†Sulphuretted hydrogen	0·31
Loss on analysis	0·61
	100·00

* Principally clay-slate.

† This represents about seven volumes of the gas, and this would, but for some restraining influence, expand to more than twenty volumes of the stone when heated to a red heat. It is evident that the influence that keeps it in the finely powdered stone is of a very powerful nature.

ART. LIV.—*Further Results obtained in support of my Theory as to the Oxidation of Gold in presence of Air and Water.*

By WILLIAM SKEY.

[*Read before the Wellington Philosophical Society, 15th February, 1893.*]

JUST recently, in a contested patent case in connection with Macarthur Forrest's patent process for the extraction of gold from its matrices, I had to devise experiments to rapidly decide as to whether or no chlorine and bromine, when added to cyanide solution in suitable quantity, hasten the extraction of whatever gold is present.

The way I adopted for this was to prepare from Swedish filter-paper and a standard gold-solution a gold-test paper containing gold in quantity so minute that one square inch of it would only contain $\frac{1}{2500}$ of a grain of this metal.

Using this test-paper I was enabled in a few seconds to show to the local manager here for this company the effect of the cyanide process as compared with the chloro-cyanide or bromo-cyanide processes.

This method for determining the relative solvent powers of substances upon gold being so successful, I at once adopted it to enable me to take up and complete the further investigation upon the effects of air and water upon gold that I promised in volume viii. of the Transactions. It may perhaps be remembered that I there stated that the effect of acetic acid in rendering gold amalgamable that had been oxidized by contact with air and water was so singular that it required investigation, especially when such a strong reducing-agent as the protosulphate of iron had no such effect upon it. This was an anomaly, I said, that wanted an explanation.

In thinking this over, it first occurred to me that, as acetic acid renders oxidized gold amalgamable by dissolving the oxide of gold off its surface, it would dissolve gold when in presence of air and water—that is, it would dissolve the oxide formed, and so ultimately take up the whole of any minute film or deposit in a few hours. However, on performing the experiment, I was unable to detect any removal of gold by this acid, though I allowed fourteen days for the operation.

It appears, then, to me that the oxide of gold, or possibly the carbonate of oxide of gold, that has formed on the gold as a film protecting it from the mercury, has been converted into acetate of gold by the acetic acid, and, this being easily decomposed by the mercury (while the oxide or carbonate is not), amalgamation proceeds. That hydrochloric acid also

renders this oxidized gold amalgamable may be explained in the same way; while the inability of sulphuric acid, or the iron-sulphate, to render gold amalgamable leads me to suppose that a basic sulphate of gold forms on the metal when these substances are used, and that this sulphate is not, or at least is not readily, decomposed by the mercury, so the amalgamation of the gold is much delayed or altogether impeded. This explanation of the anomaly referred to seems feasible to anyone who will compare this behaviour of gold with that of silver under much the same circumstances. This metal (silver) becomes rapidly non-amalgamable in distilled water, and, like gold that has been in the same water, becomes easily amalgamable by contact with hydrochloric acid or a chloride, and this *solely, as we know,* by a changing of the oxide or carbonate of silver that has formed in the distilled water into a chloride, which salt is rapidly decomposed by mercury, and so amalgamation readily proceeds.

This appears to me a satisfactory explanation of the anomaly described in my former paper, supposing that, as I allege, the refusal of gold that has had contact with air and water to amalgamate is really owing to its having been superficially oxidized therein; and that this is so I am now enabled, by the use of my gold-test papers, to demonstrate beyond all doubt.

Now, as every chemist and photographer knows, most of or all the compounds of gold with the other elements except sulphur and its congeners are soluble in hyposulphite of soda. This salt, therefore, in conjunction with air and water, should dissolve (metallic) gold—that is, it should (if the gold is oxidized under these circumstances) dissolve the oxide or carbonate of gold formed thereon, and so ultimately take up the whole of the gold present in my test-paper within a reasonable time.

Acting on this supposition I tried the experiment, and found that if only the "hypo." is prevented from breaking up into sulphide compounds the gold is all quite removed from the paper in a few hours by the hypo. If we use the hyposulphite alone there is no certainty of result, as it is so easily decomposed to form a salt (sodic sulphide) that produces sulphide of gold, a compound not soluble in the hypo. By putting a little potash in the hypo. this decomposition is prevented and the gold is always completely removed. It was afterwards found that ammonia even has a solvent effect upon metallic gold, but its action is considerably slower than that of the hypo. Potash alone, it may be stated, did not show any solvent power upon gold.

That gold is, as shown above, soluble in hyposulphite of soda, also in aqueous ammonia, proves beyond all doubt that

it is (as I publicly asserted sixteen years ago) oxidized as iron is in the presence of air and water; for the only conceivable effect of either of these reagents (hypo. and ammonia) is to dissolve the auric compounds that can and do form upon the gold independently of their presence. As regards the solvent effect of potassic cyanide upon gold, this salt also only acts upon the gold that has been oxidized by air and water. This oxide or its carbonate it removes, and so exposes fresh gold-surfaces to be oxidized by air-water. It should be stated here, in justice to Elsner,* that before my first paper on this subject was read here this chemist proved oxygen is necessary to the continued action of potassic cyanide upon gold; but he did not venture any statement as to the *mode* in which this gas acted in the process of solution.

These results have a practical value in relation to Cassell's cyanide process when applied to free gold, for in this state the metal has to be oxidized by the oxygen contained in the water before it can be taken up by the cyanide; hence we may properly conclude that stirring the solutions, free access to air, and even the aëration of the cyanide-solution would greatly assist the process of gold-extraction by the use of this salt. Any way, all depends very much on the free supply of oxygen in the solution; consequently, the nature of the water used has to be considered. In ordinary river-water, which is generally well aerated, it may be assumed about 2gr. of oxygen is present to the gallon. This is competent to oxidize 1dwt. of gold to the mono-oxide. We do not yet know really the formula of the oxide formed, but I assume it does not contain a greater proportion of oxygen than this compound does. This seems an ample supply of itself, leaving out the oxygen that enters the water as the process is going on: but much depends upon the rate at which this gas (oxygen) diffuses itself in water—a matter which I think chemists do not as yet know much about. Any way, a brisk circulation of the cyanide-solutions as applied upon *free gold* must prove beneficial, because it materially helps in bringing oxygen in contact with the gold that it is required to extract.

For the convenience of any one desirous of testing the accuracy of my statements regarding the solvent powers of hypo. and ammonia upon gold in contact with air and water, I give an easy method for preparing a delicate test-paper of regular composition.

Dissolve 1gr. of gold in nitro-muriatic acid, and dilute to 10 fluid-ounces. Immerse in this a piece of dry Swedish filter-paper that has been just previously well washed in water. Take the paper out and let it drain till no further dripping

* Watt's Dictionary of Chemistry, vol. ii., p. 213.

ensues, then place it in a horizontal position over ammonia-vapour. The gold-oxide precipitates, and can all be evenly reduced in the paper by warm oxalic acid. Test-paper so produced has a regular and easily-perceptible purple or red tinge, and contains about $\frac{1}{2500}$ of a grain per square inch. Paper containing $\frac{1}{10000}$ per inch, or $\frac{1}{1000000}$ of a grain of gold on $\frac{1}{10}$ of an inch square, has a very faint tinge; but, still, this can be discerned upon a clip of the paper that contains only $\frac{1}{20000000}$ of a grain of gold if we place by the side of that clip for comparison a piece of the same kind of filter-paper upon which gold has not been deposited. Some idea of the almost imponderable quantity of visible gold thus dealt with and accurately measured off for experimental purposes may be realised when it is considered that a grain weight stands about halfway between this weight and a ton weight.

By using this delicate test-paper the accuracy of Professor Eglington's assertions as to the solvent property of alkaline sulphides upon gold is easily and quickly to be confirmed, and I have even observed by the same test a very feeble solvent power of warm sea-water, also carbonate of soda, upon the same metal.

I hope to take this subject up again soon, and give the results of further experiments I intend making in connection with it.

IV.—MISCELLANEOUS.

Art. LV.—*Causes of Fires on Shipboard and Elsewhere.*

By J. C. Firth.

[*Read before the Auckland Institute, 17th October, 1892.*]

The occurrence of a fire on the 21st September, 1892, on board the iron ship "Timaru," from the spontaneous combustion of her charcoal insulation, whilst lying in Auckland Harbour, again forcibly directs attention to some of the causes of fires on shipboard, and has induced me to read a paper on the subject before the New Zealand Institute. In this paper I shall confine my attention to the occurrence and causes of fires on ships arising from spontaneous combustion. I shall not treat upon the numerous fires on coal-ships arising beyond all doubt from the spontaneous combustion of the coal on board, as this branch of the subject does not come within the limits of this inquiry. The increasing wants of our times have called for improved facilities for the preservation of perishable articles of food, and for their safe transportation from producer to consumer. These objects are secured by freezing and insulation ashore and afloat, the insulating-material being charcoal. It has been found, however, that many mysterious fires have occurred in connection with these cooled-chambers both on land and at sea.

These fires have at length aroused the attention of a portion of the sea-going public and of some of the insurance offices, and, unless means can be found to prevent their occurrence, a growing feeling of insecurity amongst passengers, with greatly-increased insurance-rates, are certain to result when the danger becomes more fully known.

The cause of many of these fires is to be found in the material used for insulating purposes—namely, charcoal, which fairly secures insulation, but its tendency to spontaneous combustion renders its use highly dangerous. Though I have long and carefully studied this subject, I should not have ventured my own opinion on a matter upon the right treatment of which the lives of thousands of sea-going people

depend, as well as the safety of an enormous value in ships and steamers using charcoal as an insulator, but that my opinion is supported by the investigations of many men of high rank in the scientific world, as well as by well-authenticated instances of fires occurring from the spontaneous combustion of charcoal, both ashore and afloat.

The first authority I cite is that of Mr. F. C. Moore, president of the Continental Insurance Company, New York. In his work entitled "Fires," published at New York (1877), Mr. Moore says, "Charcoal will burn when pulverised, or when finely divided in heaps. Twenty or thirty hundredweights of charcoal, in a state of minute subdivision, are almost certain to burn spontaneously. In an experiment made in France, under Government supervision, it was found that the inflammation occurs towards the centre of the mass, at about five or six inches below the surface. The temperature is constantly higher at this point than any other. In another instance, where small charcoal was thrown into a heap 10ft. square and 4ft. deep, containing two or three tons of charcoal, the temperature had increased in three days to 90^{c}, though at first only 57° (that of the air at the time). On the sixth day it was 150°, and on the seventh day combustion had occurred in several places. The charcoal had been made ten or twelve days before the experiment took place, had been freely exposed to the air, and was not in any sense what is known as 'freshly-burned' charcoal. When finely powdered, charcoal is more dangerous than when in sticks. Sixty pounds of powdered charcoal is sometimes a large enough quantity to ignite spontaneously. Lumps of charcoal, if moist, and subjected to a slight drying heat, will ignite."

Professor C. J. Jackson (United States) reports, "Three times I have set fire to charcoal at temperatures below that of boiling water. My first experiment or observation was accidental. I was preparing, while at Bangor, Maine, for a lecture, in which I had occasion to show an artificial volcano. I took a tray filled with gunpowder, and laid it on the stove to dry. I then took a paper of pulverised charcoal, such as is sold by apothecaries for tooth-powder, the charcoal being wrapped in white paper, and placed it on the top of the gunpowder which was being dried upon the stove. Having occasion to go out, I took off the paper of charcoal and laid it upon the table. When I came back, in twenty minutes, I observed the paper smoking. The charcoal was completely consumed. During all this time the gunpowder remained on the stove unexploded. My next observation was this: While at work in my laboratory I had occasion to use a piece of charcoal for blowpipe experiments. I went down into my cellar and brought up a piece of light, fine, round charcoal suited for the purpose. It was

damp. I laid it on the top of a column stove to dry, directly beside a tin pan containing water which was not boiling, and which never did boil there. I took the charcoal off the stove and laid it on my table. A short time afterwards I discovered it was on fire all through the piece. I laid it aside, and it burned entirely to ashes. The theory of the ignition of charcoal under these circumstances struck me at once. Charcoal has wonderful porosity; it has the power of analysing air, and of absorbing the oxygen with comparatively little of its nitrogen. The pores of the charcoal were previously filled with moisture. The oxygen of the air was condensed in the charcoal, taking the place of the moisture. The condensation of the oxygen produced heat to ignite the charcoal. I repeated the experiment again, intentionally, watching it carefully, and with the same results."

Professor Bloxam, one of the most eminent authorities on the spontaneous combustion of charcoal, says, "Charcoal absorbs mechanically into its pores nine times its volume of oxygen. The compression of a gas always evolves heat. Hence the temperature of the charcoal would be raised. If this goes on quicker than the heat is given off (charcoal being a bad conductor of heat, any heat generated in the interior does not escape), then we get spontaneous combustion."

M. Violette, perhaps the most eminent of French authorities on the spontaneous combustion of charcoal, says, "The charcoals from different kinds of wood, when prepared at a nominal heat of 572°, spontaneously ignite between 698° and 734°, according to the nature of the wood producing them, but the product from the lighter woods burns quicker than that of the denser woods." M. Violette goes on to say that "charcoals from the same wood, but prepared at increasing temperatures, spontaneously undergo combustion at very unequal degrees of heat."

Dr. Ure says, "The higher the temperature at which charcoal has been made, the higher is its igniting-point; therefore charcoal made from light woods, such as willow and fir, all of which can be made at a temperature as low as 300° C., are the most dangerous, being both more absorbent and more readily inflammable."

Mr. Dupont, the large American powder-manufacturer, states that "charcoal powdered and piled in a heap is liable to spontaneous ignition. He had suffered loss from this cause, and a similar accident occurred in Paris, when one of the wings of the Mint took fire through large quantities of charcoal stored in a garret."

Mr. Hares, a recognised insurance authority, states that "charcoal is liable to spontaneous combustion, especially in a ground state, when left in heaps and exposed to damp."

If further evidence be needed of the well-known and highly-dangerous liability of charcoal to spontaneous combustion, I am permitted to cite the opinion of Colonel Majendie, H.M. Chief Inspector of Explosions, in a letter to me from the Home Office dated 28th August, 1890.

Colonel Majendie says, "The liability of charcoal to heat and fire spontaneously is a well-known and firmly-established scientific fact, and has frequently formed the subject of experimental investigation. Several fires from this cause have come under our notice. So well recognised is this risk that there is a special rule in 'The Explosives Act, 1875,' as to allowing any charcoal to remain in a danger building."

The general ignorance of the liability of charcoal to spontaneous combustion is the more surprising in the face of the provisions of "The Explosives Act, 1875," some of which are as follows: "Charcoal, whether ground or otherwise, shall not be taken into any danger building, except for the purpose of immediate supply. No maker of gunpowder shall keep, or permit to be kept, any charcoal within twenty yards of any mill for making gunpowder."

The foregoing opinions and experiments of eminent authorities show with sufficient plainness that charcoal is liable to spontaneous combustion, and therefore highly dangerous.

I shall now leave the region of scientific research, and proceed to cite instances of fires which have occurred afloat and ashore from the use of charcoal as the insulating-material, premising that many mysterious fires have occurred without any cause being assigned, owing to the prevailing ignorance of the liability of charcoal to spontaneous combustion, and to the difficulty of ascertaining the cause of a fire after the complete destruction of a building or ship.

The following memorandum of marine losses in steamers carrying frozen meat from New Zealand (which I have been kindly permitted to quote), by the Surveyor of the Canterbury Marine Underwriters' Association, dated Christchurch, New Zealand, 11th April, 1890, is sufficiently conclusive: "1. Steamer 'Ionic,' sailed November, 1883; fire took place in refrigerating-chamber; 800 carcases scorched, and 5,000 carcases damaged. 2. Steamer 'Ruapehu,' on fire (said to be) through steampipes. 3. Steamer 'Selembria,' sailed February, 1888; meat on fire; 12,000 carcases condemned at Monte Video, remainder condemned on arrival in London. 4. Steamer 'Kaikoura,' on fire (said to be) through steampipes."

Subsequently to the above fires, the "Ashleigh Brook" arrived in London on fire (said to be) in her bunkers; 1,025 carcases consumed.

The steamer "Ionic," lying in the London Docks, took fire on the 24th December, 1889, and again on the 26th December, 1889. In both cases the charcoal insulation was badly burnt, and without doubt caused both fires.

The "Moorish Prince" steamer, while lying in the South West India Dock, took fire on the morning of the 10th September, 1890. The steamer was laden with charcoal and timber, and (as reported in the London *Evening Standard* of the same day) from some unknown cause a large quantity of the charcoal took fire.

Towards the close of 1891, the P. and O. steamer "Rome," lying in dock at Greenock to be lengthened, took fire. The fire was cabled as having been caused by her charcoal insulation. Though this was afterwards denied, "as believed to have occurred through a candle being left burning by one of the workmen," it may be one of the "mysterious fires" where, for obvious reasons, any cause of fire is accepted rather than the true one.

In this connection it may be noted that the frozen-meat ships "Dunedin" and "Marlborough" (both insulated ships) were never heard of after leaving the New Zealand ports of departure. There can be hardly any doubt that both were burned at sea, with all hands, owing to the spontaneous combustion of their insulation.

I now come to the fire on board the iron frozen-meat ship "Timaru" (insulated with charcoal about two years ago). The "Timaru," lying in Auckland Harbour, had been discharged, and was waiting for a charter, having nothing in her but some barrels of cement for stiffening. On the morning of the 21st September, 1892, the "Timaru" was found to be on fire in her charcoal insulation (the ship being fitted up for carrying frozen meat). Owing to exceptionally favourable circumstances, the fire was extinguished before very much damage had been done. Had the fire occurred in mid-ocean the ship would have been destroyed with all on board. In that case no evidence of the fire would have been forthcoming, and, as in so many other cases, the final and only report would have been, "Ship 'Timaru' never heard of."

The fire on the "Timaru," without any question or doubt, was caused by the spontaneous combustion of her charcoal insulation, as will be seen from the reports of the various official surveys held on board her immediately after the fire by Captain H. Worsp, for the Auckland Marine Underwriters' Association, and Captain M. T. Clayton, for Lloyd's Agent in Auckland, and for Lloyd's Registry, London. From these exhaustive reports I am permitted to make the following extracts:—

Captain Worsp says, "The fire on board the ship 'Timaru'

was, in my opinion, due to the spontaneous combustion of the charcoal insulation."

Captain M. T. Clayton says, "I examined the locality of the fire on board the ship 'Timaru,' and enclose plans of the situation. I believe the fire originated from spontaneous combustion (of the charcoal insulation). The fire burnt upwards from the charcoal, and nearly burnt through the deck before it was discovered."

Mr. Rose, H.M. Collector of Customs at the Port of Auckland, also held an inquiry on the fire on the ship "Timaru," and, after taking the fullest evidence, reports the fire to have occurred from the spontaneous combustion of the charcoal insulation.

There are now more than thirty steamers and six ships engaged in the New Zealand frozen-meat trade, with a tonnage of about 130,000 tons, costing, say, two millions sterling, and carrying yearly (including about two million sheep) exports and imports to the annual value of £12,000,000 sterling. These amounts involve an annual payment of about £250,000 per annum for insurance.

Will it be believed that every one of these steamers and sailers is carrying along with it an element—charcoal—proved by the experiments of experienced scientists to be liable to spontaneous combustion, which the numerous fires from this cause show to have long since passed out of the region of experiment?

The form in which charcoal is generally used for insulating purposes is in small irregularly-shaped pieces. In this form the interstices between the pieces of charcoal are filled with air, which renders the insulation incomplete, and which requires a large extra amount of coal to correct this imperfect insulation and keep down the temperature to the required point. When these air-spaces become partially filled by fine charcoal, resulting from the slow grinding action inseparable from the continual motion of the steamer, the dangers from spontaneous combustion are greatly increased.

In corroboration of the dangers arising from the spontaneous combustion of charcoal when used as the insulating-material in ships or freezing-works on shore, I am permitted to make the following extract from a report upon evidence taken by the Insurance Association, Christchurch, New Zealand, on a fire in the Belfast Freezing-works, near Christchurch, dated the 5th November, 1888, kindly placed at my disposal by the insurance authorities there:—

The report by Mr. Secretary Madden to the chairman of the Insurance Association says, "In forwarding you the evidence in connection with the fire at Belfast, I have to call your attention to that of Huston, Glass, and others, who are

positive as to where the fire originated. Their evidence entirely upsets the theory that the fire originated from any sparks getting under the eaves of the building. It is very clear that it started in the ceiling of No. 5 freezing-room, which was composed, firstly of timber, then charcoal, and then sawdust. This being the case, had a spark falling on the roof (which was of iron) been the reason of the fire, it would have caused the sawdust to ignite. It is well known that had this occurred it would have smouldered for hours, and been seen. Apart from this, had such occurred the fire would have been first seen through the roof; whereas the evidence shows that such was not the case. Mr. Glass (chief engineer) says, 'The fire had burnt a small hole in the ceiling of the cooling-chamber.' This statement is corroborated by others. This brings one to the question, 'What was the cause of the fire?' Having carefully considered the matter, I am of opinion that it originated from spontaneous combustion (of the charcoal insulation)." In support of this conclusion the secretary quotes several well-recognised authorities, and concludes his report by stating that, "if (as these opinions prove) the fire at the Belfast Works did occur from spontaneous combustion, it is undoubtedly a question for very serious consideration not only in connection with freezing-works on shore, but also as regards vessels taking frozen meat to London." This fire cost the insurance companies about £20,000. Three years ago a fire occurred at Hull in a cooling-chamber insulated by charcoal. On the 15th September, 1890, a fire occurred in a building used by the Chargeurs Meat Company at Havre, France, when 8,000 frozen sheep, and the refrigerating apparatus, were destroyed. Damage, £20,000. In both these fires the cause was reported as "unknown," but is believed to be due to the spontaneous combustion of the charcoal insulation employed.

As yet the frozen-meat trade is only in its infancy. If, in the short period it has been in operation, so many fires have occurred, with charcoal and sheathing new and in good order, what disasters may not reasonably be looked for when the charcoal becomes more or less reduced to a powder—its most dangerous form—and when the wooden linings of the cooled-chambers undergo the natural decay inseparable from the intense cold to which they are exposed on the homeward voyages, followed by the complete thawing on the outward voyages, and so permitting melted snow, moisture, air, and oil to enter the charcoal insulation! When a portion of the charcoal becomes sufficiently damp to enable it to analyse the air, oil, or water with which it may be brought in contact, it slowly condenses the oxygen, and becomes saturated with it during the subsequent drying process.

This subtle process may be slow. It is naturally very unequal in the time required for its completion, for, as M. Violette observes, "Charcoal made from various kinds of woods ignites spontaneously at different temperatures; made even from the same wood it ignites spontaneously under very unequal conditions."

It is well known that freshly-burned charcoal is most subject to a speedier spontaneous combustion; but the conditions attending the spontaneous combustion of charcoal are uncertain and subtle, and their investigation has not yet been complete enough to enable a time to be fixed when a fire will certainly take place. The subtle process may require months. or years to complete. Its conditions are necessarily unknown, and cannot be detected until, by the heat from a steampipe, or by the heat of the tropics, or in some other unexplained way, the point of combustion is reached, when a fire occurs.

We must consider that, through leakage, bilge-water, a few drops of oil, or from rats eating through the charcoal casing, the charcoal used for insulating may at various undiscovered points become damp; when that happens the first stage of the process begins. The next stage, as before stated, may be deferred for a short or a long period, but it is only biding its time. Its progress is necessarily unknown, and cannot be detected until, in most cases, long after the point of combustion has been reached. It is easy enough to understand how this dangerous process operates, but it is often impossible to ascertain either its commencement, development, or progress, till too late.

With charcoal as the insulator, immunity from fires, almost certain to occur sooner or later, cannot be secured. It is idle to say that many charcoal-insulated steamers make voyages without taking fire. Escape from a disaster for a longer or shorter period gives no guarantee that it will never occur if every steamer carries with it the elements of incipient destruction, any more than a man with heart-disease can ever be certain that, because he has carried the disease about with him for years with impunity, a sudden catastrophe will never strike him down.

Let but a frozen-meat steamer be burnt in mid-ocean in consequence of carrying so dangerous a material as charcoal for insulation, and not only will a great loss of property take place, attended by a great loss of life, but, unless all hands perish, the usual report at Lloyd's of ships lost under such conditions will be "Lost at sea, cause unknown." But if a few survivors escape the perils of the fire and the sea to report the cause of the ship's destruction as having arisen from the spontaneous combustion of her charcoal, then shipowners and shippers may expect a general advance of insurance rates all

along the line, to be followed by an avoidance by passengers of all steamers carrying frozen meat. Nor will the matter end there, for in these days every passenger-steamer is provided with a charcoal-insulated chamber to carry its fresh provisions for use on the voyage.

It may therefore as well be remembered that it is by no means beyond the limits of probability that it may be the fate, sooner of later, of many or most ships and steamers carrying frozen meat or other articles in cooled-chambers insulated with charcoal to be burned at sea, if this highly dangerous material continues to be used for insulating purposes.

Gunpowder, which will not ignite except by a spark or light, is surrounded by precautions; yet, notwithstanding the accumulation of scientific opinions and experiments, and the occurrence of many actual fires demonstrating the liability of charcoal to spontaneous combustion, steamers and property aggregating more than a hundred millions sterling in value, together with tens of thousands of seamen and passengers, are every year sent to sea, carrying along with them charcoal, a material far more dangerous than gunpowder—so full, indeed, of the elements of catastrophe that public opinion is not likely to tolerate such a condition of things much longer.

It is evident, therefore, that the use of charcoal as an insulator is full of danger to all parties — steamship-owners, freezing- and dairy-works proprietors, insurance companies, and sea-going people generally. The dangers incidental to the sea are serious enough without increasing them in an unnecessary manner by sending ships to sea with such a dangerous article as charcoal on board.

Unless a safe substitute for charcoal be available, then great losses of life, of shipping, and other property, followed by much higher insurance-rates, lower prices for sheep or higher prices of meat to consumers, are looming in the not very distant future.

I should not have undertaken an investigation so arduous and unsatisfactory unless I had believed in the existence of a material as a safe and perfect substitute for charcoal, for he is but an indifferent doctor who tells you that you are suffering from a disease, but fails to point out a remedy.

For many years I have been acquainted with the peculiar properties of pumice, a product of New Zealand and of two or three other countries. In the course of my investigations I have made many careful experiments, with the result that I have ascertained that amongst the several kinds of pumice one or two varieties are suitable in the highest degree, when properly prepared, as a safe and perfect substitute for charcoal for insulating purposes, for the following reasons:—

1. Pumice, properly selected and prepared, is altogether

unaffected by heat, and is one of the best non-conductors of heat or cold known. One end of a piece of it, 2in. long and ¼in. square, may be placed in a gas-jet for two hours without sensibly raising the temperature at the other end, whilst a piece of iron of the same size becomes red-hot in half the time.

2. It is not in the least affected by the most intense cold.

3. It is unaffected by damp or moisture, never developing the smallest approach to heat-fermentation, never generating any fungoid growth, or taint of any kind.

4. It is absolutely free from the least tendency to spontaneous combustion. It cannot even be fused alone by the most intense heat.

5. Rats will not touch it.

6. Pumice is extremely light when properly selected and prepared, being about the same weight as charcoal.

7. It is perfectly clean, more satisfactory to handle than charcoal, and in case of accidental escape from the insulating-walls it does not blacken or soil, like charcoal, the frozen meat, or the bags which contain it.

8. In case of fire occurring, from any cause, in any one compartment of an iron steamer or ship, if the bulkheads be made double by an additional sheathing of thin iron at the back, and the prepared pumice be filled into the space, then not only do the bulkheads so filled in secure the original objects of strength, and safety from water, but these bulkheads so filled—with very little addition of weight—will prevent absolutely any fire occurring in one compartment from spreading through the bulkheads to the next compartments, with the further safeguard of the complete prevention of any heat from the boiler or engine compartments to the insulating-walls of the cooled-chambers, and removing one of the most dangerous elements of combustion from that cause where charcoal is used.

I have only to add that the use of carefully-selected and prepared pumice as an insulator, in place of charcoal, on all steamers and ships having cooled-chambers, will secure absolute and perfect immunity from fires from spontaneous combustion, besides rendering a fire on board arising from other causes more manageable by the absence of charcoal, which only adds fuel to the conflagration, whereas the pumice-filled bulkhead, as before described, presents an impenetrable barrier to its progress.

By the substitution of prepared pumice* in steamers, or freezing-works on shore, in place of the charcoal now in use as the insulator, an absolute safeguard will be provided against all fires from spontaneous combustion; it will remove the uneasy feeling current among the better-informed insurance offices

and underwriters, relating to the mysterious fires occurring in steamers and freezing-works now using the charcoal insulation; it will altogether prevent the awful and unnecessary perils to which seamen and passengers are now exposed in steamers using the charcoal insulation; and will remove the very natural uneasiness which all seagoing people will feel as the danger becomes better known.

POSTSCRIPT.—Since this paper was read, a fire occurred on board the iron frozen-meat steamer "Ruahine," 370 miles from St. Helena, on her outward voyage. The lower hold of the steamer was insulated with charcoal. On her arrival in the Port of Auckland, New Zealand, Mr. Rose, H.M. Collector of Customs at the port, held an inquiry as to the cause of the fire. The investigation showed that the fire originated in the charcoal-insulated No. 4 compartment; that much cargo and a large portion of the charcoal insulation was consumed; that no communication with No. 4 hold had occurred during the voyage; that the burning charcoal insulation greatly intensified the fire; that the charcoal fumes nearly suffocated some of the crew; and that no other cause of the fire could be found than the spontaneous combustion of the charcoal insulation.

ART. LVI.—*Maori Nomenclature.*

By T. H. SMITH, formerly a Judge of the Native Land Court.

[*Read before the Auckland Institute, 5th September, 1892.*]

THE subject to which I have presumed to invite your attention this evening, though interesting to myself and probably to others who have some acquaintance with the Maori language, is yet one which, I fear, I may not be able to treat in such a way as to make it interesting to a general audience. I will therefore anticipate failure by asking you beforehand to forgive me should I trespass unduly upon your patience while making the attempt. I propose, then, to say a few words on Maori names.

The subject seems to fall naturally under three heads—names of persons, names of places, and names of things.

With regard to names of persons: The first point which appears to me noticeable is that a Maori often bears a great many names in his lifetime. The principal name is, however, given at birth, or, rather, in the case of a male, at the ceremony which is performed soon after by the priest or *tohunga*.

In after-life the birth-name is often dropped, and a fresh one is assumed, often bearing reference to some important contemporaneous event. Sometimes on the decease of a relative the name of the deceased is assumed by the survivor. Often, also, a circumstance or occurrence associated with the sickness or death of a relative furnishes names for those who were about him at the time of his decease.

I do not think there is any rule observed with regard to names of chiefs or persons of rank. At the same time there are distinctions in names—there are aristocratic names and plebeian names. The "Rangi's" and the "Tu's" generally, when at the beginning of the name, belong to the former, and such names as etymologically suggest relations to common every-day affairs are generally borne by persons of low degree. This cannot, however, be laid down as a rule. Some of the highest-born and most renowned chiefs have borne names of by no means exalted significance. It may be that the names of many of the men who gained renown as warriors and otherwise were not their birth-names, but merely the names by which they were known during the time they were winning fame by their exploits, and therefore the names by which they chose to be known and spoken of.

The Maoris did not generally distinguish sex by names. With certain exceptions, any name may be borne by either sex. The exceptions are that names beginning with "Hine" or "Pare" will belong to females, and names compounded with "Tama" or "Tu" would be those of males only.

The definitive "Te" put before a name adds dignity, and is used as a mark of respect. In metamorphosing pakehas' names into Maori it is usual to put the "Te" before them, where it is probably equivalent to our "Mr." To omit the "Te" in speaking of or addressing a respectable pakeha would show lack of respect, though in familiarly addressing him it may be omitted, and the name itself even may be abbreviated without disrespect. In the case of their own names, those which are preceded by the "Te" certainly mark higher rank in the bearer than those not so preceded. I remember a chief of high rank in the Lake district whose name was *Te* Kirikau, and in the same place was a little schoolgirl named Kirikau. The distinction, though seemingly trifling, was not really so, the names having different significations. It was quite sufficient to prevent any mistake or confusion in their use.

There is a word sometimes used in greeting a person held in high estimation for his genial and good qualities—"Tauwa." It expresses at once admiration and respect for the person so accosted, also pleasure at meeting.

In addressing any person, by name or otherwise, the vocative "E" is always used. This has led to many mistakes of

pakehas in using Maori names. Hearing persons addressed, they have taken the preceding "E" to be part of the name. The chief Te Puni, of Wellington, was always known by the European settlers as "E Puni." A great many similar instances might be given.

There are no family names among the Maoris. Every child has his own name given soon after birth, which is retained through life, though not always used. A person may take many names. The so-called Maori King, Potatau, was known as "Te Wherowhero" in the early days of the colony. The name of the head of the family, however, comes into use by his descendants as the name of a hapu or tribe, generally by adding the prefix "Ngaati" or "Ngai"—Ngatiwhakaue, at Rotorua—the family or descendants of Whakaue; Ngai Te Rangihouhiri, in the Bay of Plenty—the descendants of Te Rangihouhiri: both of these prefixes meaning the same—*i.e.*, progeny. In some cases the singular form is used, as "Te Atiawa" instead of "Ngatiawa;" and other forms also are used, as "Te Whanau o," "The family of"—Te Whanau o Apanui, on the East Coast—or, "Te Uri o," "Te Aitanga a," "The offspring of"—Te Uri o Hau, Kaipara; Te Aitanga a Whare, Poverty Bay, &c.

It is not meant to assert that the names of tribes and hapus are invariably, or even generally, those of ancestors; but in many cases it is so, and the use of these prefixes would always be understood as indicating the family of the name so prefixed. Families of some of the early missionaries, which have multiplied and reached to the third and fourth generations, are often so designated.

In speaking of Maori names, of course the names given in Christian baptism are excluded.

There is a remarkable Maori custom, which in bygone days used to be very strictly observed. If a chief changed his name, as in the cases above referred to, and took as a name a word in common use having any connection with food, some other word was forthwith substituted for the word so appropriated, which thereafter ceased to be used. I recollect instances of this in the Bay of Plenty. A chief took the name of Te Wai Atua (Spirit-water), and forthwith the word "*ngongi*" was substituted for "*wai*," which was dropped, both words meaning water. In another case the word "*kai*" (food) formed part of the names assumed by chiefs—Korokai and Nga Kai. The use of the word "*kai*" for food ceased in consequence, and the words "*kame*" and "*tami*" were used instead.

Other peculiar uses of names were the *tapatapa* and *tukutuku*. To *tapa* anything was to give the name of a person to it, the effect of which was to put it, figuratively, into the keep-

ing of the person named, after which any other person taking a liberty with it would be regarded as offering insult to the person whose name had been so used. The object was to associate the person named with the owner or claimant in defending or maintaining possession of the thing "*tapa*"-ed. To resort to this mode of proceeding was regarded as a gross insult to the rival claimant, who was thus baulked in any attempt to possess himself of the property in dispute, and it often led to reprisals in some shape. The form of *tapatapa* was, "Waiho te mea ko Mea"—"Let the thing be So-and-so." It was throwing down the gauntlet—not your own glove, but that of some other person. Another use of a name was in time of war, threatened or actual: a chief of high rank nearly connected with both belligerents, if desirous of preventing or ending strife, would sometimes name a war-path his backbone, "*Iwi tuaroa,*" and if, after his having done so, either side used the path with hostile purpose, it would be regarded as a mortal offence, to be wiped out only in blood.

Other peculiar uses of names of persons, and Maori customs connected with them, might be noticed, but, with your permission, I will pass on to Maori names of places, as the part of my subject to which I propose to devote the larger portion of the time allotted to me.

In entering upon this branch of my subject I would take the opportunity of expressing my regret that we colonists, having adopted Maoriland as our country, professing our wish and intention to occupy it together and upon equal terms with those who were here before us—its original possessors—should have allowed so many of the native names of places to fall into disuse—should consent to let them be lost or forgotten. We have built cities, and we were right to give them names. Our houses, our streets, our roads—everything which we have brought into being—we were warranted in naming. But the mountains, the bays, the rivers, lakes, forests, the grand natural features of these Islands, had names before we came here, and why should they not be preserved? Is it well or creditable to our sentiment that they should pass into oblivion?

It has been said that Maori words are so difficult of pronunciation. I quite fail to understand how it can have come to pass that Maori words or names should be thought difficult to pronounce. It appears to me that the sounds of the Maori language are so few and so simple that, if two or three plain rules are observed, no name or word need present any serious difficulty. If only it be borne in mind that the language is dissyllabic;—that the vowels have the Continental sound; that every syllable ends with a vowel—in fact, consists of a single consonant followed by a vowel, or of a so-

-called single vowel which can be uttered by the voice as a single sound capable of being prolonged indefinitely;—that names having many syllables are compound words, and may be broken up, as it were, into their component parts, which may be dealt with separately, as a preliminary process;—I believe that any difficulty apparent on first sight will vanish. Simplicity is the main characteristic of the Maori language—indeed, I cannot conceive of anything more simple, so far as the mere pronunciation of the words is concerned. Its words are formed from dissyllabic roots, each syllable being compounded of a consonant qualified by a vowel, which is required to make it utterable. The consonant sound at the end of a word, found in other languages, is—excepting only in the case of the sibilant—incapable of being dwelt on or prolonged, and the fact that all Maori words and syllables end with a vowel (which may be so prolonged) makes the language remarkably adapted for singing.

I may here say that I differ from some of the recognised authorities on the question of the sounds which go to make Maori words as spoken by the Maori, and which are represented by fifteen letters or signs—five vowels, with eight single and two double consonants.

The Maori language was, as we all know, reduced to writing by the early missionaries, who caught, as it were, the utterances of Maori speakers, and endeavoured to reproduce them by using these English letters, and it is remarkable how well adapted and suitable for the purpose they prove. Still, as equivalents for the Maori sounds they are not perfect. Among the consonants the English "r" approximates only to the sound of the correctly-pronounced Maori word spelt with that letter. That sound might be described as a compound or compromise between "d," "l," and "r," partaking of, or approaching to, the sound of all and each. (It may be observed here that English-speaking people pronounce the "r" in different ways.) In an early attempt to reduce the Maori language to writing, made by Professor Lee in the year 1820, these three letters were given as used by the Maoris, and instances are given in his vocabulary of the use of the "d" in words which are now spelt with the "r" only. The fact is that none of these letters give exactly the proper sound. As caught by the ear of the careful listener, with the vowels "a," "o," and generally with "e," the sound is like our "r," as in *ra, rangi; repo, rere; roro, raro.* With the vowel "i," it often sounds like "l"—*ringa-ringa*, almost *linga-linga*. With the vowel "u," it is more like "d"—*rua, runga,* almost *dua, dunga.* The name of a noted chief in the Bay of Islands, which we now spell with "r," was in the early days spelt and pronounced "Duatara."

The sound represented by the letter "t" is something between "t" and "th"—a "t" pronounced thickly.

Words usually spelt with the aspirate "h" are differently pronounced in different parts of New Zealand. In the North it is almost a sibilant. The Ngapuhi Maori says "E hoa," &c. (not "soa," or "shoa," but between these two). In old books names now spelt with "H" are spelt with "Sh"—"Shungee" for Hongi, "Shukianga" for Hokianga. In the South, among the Whanganui tribes, the place of the aspirate is taken by a sort of jerk of the voice. The Whanganui man does not say "E hoa!" but "E 'oa!" "'aere mai!" "'o mai." Hence many persons have fallen into the error of writing the name Whanganui without the "h"—Wanganui. The Whanganui Maori does not, however, simply drop the "h"—he substitutes for it the jerk of the voice: he does not say, for *he hara* (an offence), *e ara* (arise), but *'e 'ara;* not *omai* instead of *homai,* but *'omai.*

The nasal sound indicated by the letters "ng" is by some persons found difficult to master. The difficulty is, I think, more apparent than real. It is merely putting to the *beginning* of a word the nasal or ringing sound with which we are familiar at the *end* of a word, as in "singing," "speaking," &c. The child who sings "Ring*a* ring*a* rosie," twice gives the sound of the "ng," with the vowel "a"—"nga." It is equally easy to get the sound of "ng" in combination with the other vowels, thus: "Flow*ing e*ver," "br*inging o*ver," "spread*ing oo*ze." (Not, however, with the hard "g" sound—*e.g.*, we must not say "flowing-gever," "bringing-gover.") In these words the "ng" occurs four times. If they are repeated slowly, and the nasal sound is prolonged each time it occurs, so as to blend with the vowel which follows it, you cannot help getting the sound of the "ng" in combination with the vowels "e," "i," "o," and "u."

With respect to the vowels, I believe I stand almost alone in the opinion that "a" has but one sound—as in the English words "far," "father." Archdeacon (afterwards Bishop) Williams, in his dictionary, gives a second sound—as in "water." Dr. Maunsell gives two sounds—as in "fall," and as in "fat." It is a question of ear. If my ear has been true to me, there is no such sound in Maori as we give to the "a" in "water," to the "a" in "fall," or to the "a" in "fat." It is that of the "a" in "father" or "far," and that only. The ear is liable to be misled in noting the difference of sound in words in which the "a" is long from that in words where it is short—as in "mātenga," the head, and "mátenga," dying. The "a" in the latter word is often pronounced by pakehas as in the words "matter," "scatter," &c. This is wrong. An unsophisticated Maori does not so pronounce it, though I have

heard a Maori imitate the pakeha pronunciation in this and in other words. We have comparatively few English words where the "a" is pronounced as in "ārōmā," "mārvellous," and so many where it is sounded as in "rat," "cat," "bat," &c., that the error is one easily fallen into. But let it be tested by prolonging the vowel sounds, as is often done in a Maori song. If you prolong the "a" sound of the syllable "ma" in "mate," as we give it in "cat," "fat," &c., I think it will be at once perceived that the sound is not Maori at all.

The "e" has the simple French or Continental sound, and that only. The Maori "u" is pronounced like the "oo" in the English words "fool," "pool," "ooze," &c.

I also repudiate the doctrine that there are diphthongs in Maori. The combinations of vowels which are called diphthongs are simply dissyllables. Each vowel has its own perfect proper sound. There is no coalescing or blending of sound. *Ae* is as much a dissyllable as *ate; ai* as *ahi, ati, api; ao* as *amo, aro, apo; ei* (in *nei*) as *emi; au* as *ahu, aru, atu, aku.* In every case the vowels are, both in sound and in form, as perfect dissyllables as when standing in the same position relatively, with a consonant between them, and the terminal vowel sound is capable of being prolonged indefinitely. The written vowels which learners are told to pronounce long are really dissyllables, which, strictly speaking, should be spelt with the vowel letter doubled. *A* (to drive) should be spelt *aa.*

To illustrate my meaning I will take a word—*păpă.* This is a dissyllabic root-word containing the idea of flatness or extension of surface, which appears in many of its compounds —as, *haupapa, kopapa, tipapa, paparahi, paparite,* all carrying the idea contained in the root. *Papā* or *papaa,* is another word, signifying to crackle, or explode with noise, usually spelt, however, with the same letters as the first word. *Pāpā,* or *paapaa,* is a third word, also usually spelt with the same letters, the meaning of which is "father." In the second and third words the root is *pā* or *paa,* which is a root having more than one meaning—*papā,* to explode; *papā,* to meet in conflict, containing the idea of touch, or contact. "Kua papa"—"The parties have met in conflict"—have joined battle." In the word *pāpā*—father—the root *pā,* to touch, suggests the idea of touch or connection in the paternal relationship—*pa-kuha,* connections by marriage.

Reverting to the question of the proper pronunciation of Maori names, I repeat that in my opinion no insurmountable obstacle stands in the way of any one desiring to acquire the art—or accomplishment.

As exemplifying the mode in which a Maori name of several syllables may be dealt with, I will take one in connection with

which it is said one of our eminent legislators, having to refer to a block of land known by this name, found a difficulty in the pronunciation, and negotiated it in a somewhat summary fashion. He wished to say something about the Kaukapakapa Block, and, having got as far as "Kau," he disposed of the rest of the name by adding "and all the rest of it": "Kau—and all the rest of it." It cannot be denied that much more formidable-looking words are met with by those who have to do with Maori names. In this case there are but three dissyllables, the third being a repetition of the second. "Kaukapakapa," one would think, is scarcely a word to be frightened at. We will take a more difficult—or apparently difficult—word, "Ngati-uenuku-kopako," which is the name of one of the Rotorua hapus, or sections of a tribe. This word is divisible into six portions, which—excepting the first and fifth—are certainly dissyllables. With the first two there is no difficulty. They are separable from the rest of the word as a prefix common to names of tribes. The remaining four form the name of the ancestor from whom the tribe takes its name, and may also be separated into two parts, "Uenuku" and "Kopako." If each of these pairs of dissyllables be taken separately—making a dissyllable of "Ko," in "Kopako," and following the simple rules previously referred to—there ought to be no great difficulty when they are brought together. The small difficulty, of course, is to know how the word should be divided; but a little familiarity with Maori names, and observation of their construction, will obviate this.

I have heard of an objection to Maori names on the ground that many of them are the reverse of euphonious. This objection is, I think, partly met by what has been said about pronunciation of Maori words. I must admit, however, that the redundancy of the "k" in Maori does not conduce to euphony. In the South, more especially, is this noticeable, as there the nasal "ng" is converted into a "k," giving a somewhat jerky, harsh character to the Maori vernacular there. In the North, however, I cannot agree that Maori names are ill-sounding when pronounced properly. When incorrectly pronounced, they may be open to the objection.

In some cases our English names of places have been adopted by the Maori, with such alteration as is necessary to make them easily pronounced by Maori organs of speech. New-Zealanders have long spoken of "Peowhairangi," Bay of Islands; "Akarana," Auckland; "Niu Tirani," New Zealand, &c. Their attempts to render English names put to shame those of the pakeha of the olden time to render Maori names into English.

The Maori has proved himself an apt scholar in appropriating English names and words. An amusing anecdote

illustrating the exercise of this faculty is told in connection with a name given to a house. Two Europeans had been employed to build the house, and on its completion a name for it had to be found. A meeting was convened, the matter was discussed, and one of the Europeans was asked to name the house. He called to his mate, sitting on the roof of the new structure, "What name shall it be, Jack?" The reply was a very coarse expression, which I will not repeat. The assembled Maoris catching the sound of the words and taking a fancy to it, they were put into Maori shape as a single word, and adopted as the name by which the house was thereafter called. In course of time the surveyors came, made their survey of the land, marking the site and getting the name of the house, which was carefully put upon their plan, where it now remains, and awaits the future New Zealand antiquary and philologist, who, if successful in tracing its origin and signification, may sympathize with Mr. Pickwick in his experience in connection with the Cobham inscription.

In murdering the Queen's English, however, the Maori is not so great an offender as is, or has been, the pakeha in murdering Maori. In the early days of the colony the Wairarapa Valley was called "Wy-drop" by the Wellington settlers. Any one calling it by the proper name would have been laughed at as a prig. On the West Coast, between Manawatu and Otaki, may be seen the site of the pa to which the chief Rangihaeata retired after the disturbances in 1846. The locality is known to the settlers near as "Bully Taffer," its proper name being Poroutawhao. Not far from there is a place which I had heard spoken of as "Jacky Town," and, being curious to find out the origin of this name, I made inquiries, with the result that I found the name was a Maori one—was, in fact, Eke-tahuna. Instances of this kind could be multiplied indefinitely. A place the Maori name of which was Te Urukapana, was known to Europeans as "The Woolly Carpenters."

The advantage of preserving native names as clues for the historian of the future is obvious to us all, and need not be dwelt upon here, but it is very desirable that these names be preserved in their correct form. A very great deal of carelessness has been shown in the past with reference to this point. Names have been taken carelessly, wrongly spelt, and otherwise faulty. A glaring instance of this is the name "Otago." There was no Otago in New Zealand until we invented that name. It is not a Maori word at all; it is only a specimen of murder perpetrated on Maori. It was the form which the name Otakou took in the mouths of the whalers and sealers who were the first pakehas resident in that locality. To come nearer home, we have a recently-opened cemetery not

far from Auckland which we have called "Waikomiti," the proper Maori name being Waikumete (Water in a wooden vessel). We wrongly call the lake across the water "Takapuna," its proper name being Pupuke. No doubt more attention has been paid of late to getting Maori names properly spelt, but there is room for improvement. Maori names are constantly incorrectly spelt in our newspapers, and worse pronounced by those who read them. I remember the struggles which took place with the name Ngaruawahia ("The Ruas of Wahia," or "The Ruas broken into"), at the junction of the Waipa and Waikato Rivers, also with Hokitika, on the west coast of the Middle Island, before the correct spelling was authoritatively fixed by the Government.

In speaking of the signification of Maori names I fear that I may disappoint your expectation. Many Maori experts have essayed the task of analysing a Maori name, separating supposed constituent parts, assigning a meaning to each, and summing up with a result highly satisfactory, no doubt, to the operator, as evincing a superior sagacity, skill, and knowledge; wanting only the element of certainty to make it valuable, or anything more than a guess. A little ingenuity and a great deal of imagination are the only requisites to enable any one to turn out a great deal of work of this kind. It is not, however, a part of my programme to add to the number of guesses, or guessers, in this department of literature. I am rather disposed to criticize some of the achievements of others in this line, with the results to which I have ventured to refer as guesses. No doubt the meanings of many Maori names are obvious—apparent on the surface. It may be safely accepted that where the word "*maunga*" forms part of the name a mountain or considerable elevation is indicated; "*manga*," a branch, as of a river; "*puke*" (generally, not always) means a hill or eminence; "*tara*," a peak; "*whanga*," a bay or large expanse, mostly of water. When such words form part of a name the meaning may not be difficult to get at.

I will give two or three instances in which I am satisfied the meaning or signification of the name has been missed, and will not weary you by adding to the list.

The name "Onehunga" is one which has been subjected to the analysis to which I have referred, the result arrived at being that the word means "light soil," "*One*" being taken as the root of a word meaning soil, or earth, and "*hunga*" as the root of words meaning light, as fur, hair, &c.

A similar treatment is applied to the name "Otahuhu." Again we have, apparently, two dissyllables, "*Ota*" and "*huhu*." "*Ota*" means to eat anything uncooked; "*huhu*" is the name of a large grub which is eaten by the Maoris both raw and cooked. Here, apparently, there was a meaning

easily found. No doubt the name was given to a place where some one had had a feast of raw "*huhu*" grubs. Unfortunately, however, for our theory, the accent in the name "Otahuhu," as pronounced by the Maori, was on the second syllable, "*tū*," which would not be the case with the words "*Ota*" and "*huhu*" (raw-*huhu*-eating).

In the name "Onehunga," also, the accent is on the second syllable. Moreover, when we come to think of it, there are hosts of names beginning with "O" and with the accent on the syllable following it. A new light dawns, and we see that O-*ne*hunga and O-*ta*huhu is the more likely to be the correct analysis, "*nehunga*" being the present participle of the verb "*nehu*," to bury, and "*tahuhu*," meaning the ridge-pole of a house.

Again, the name "Rotorua" was supposed to signify Two lakes, and in support of this theory the fact that the two lakes, Rotorua and Te Rotoiti, are connected by a stream was adduced. A more careful inquiry among the natives themselves elicited their opinion that the name signified the "*rua*"-shaped lake, "*rua*" meaning a hole or hollow scooped out of the ground, generally circular, which is the shape of the Rotorua Lake; "Te Rotoiti" meaning the *Narrow lake.*

Once more: the name of the lake "Wai-ata-rua"—called St. John's College Lake—has been the subject of ingenious speculation, some making of it "Waiata-rua," double song; others "Wai-atarua," water of double shadow, or double-imaged water.

These instances may suffice to show that very great uncertainty must attend attempts to fix the real significance of Maori names.

Reverting to the names "Otahuhu" and "Onehunga," which I would render as "Tahuhu's place," "Nehunga's place," I would draw attention to the fact that a very large percentage of Maori names begin with "O" followed by an accented syllable. In our own neighbourhood, besides the two just named, we have Okahu, Orakei, Owairaka, Orewa, Omaha, Ohinemuri, Ohaupo. In the North, Oruawharo, Otamatea, Okaihau, Omapere, Opua. In the Bay of Plenty, Ohinemutu, Otumoetai, Ohiwa, Otamarakau, Opotiki; and on the West Coast, Ohau (Hau's River), Otaki. We have also names where "te" follows the "O"—Otepopo, for instance. Looking at these names a presumption arises, which in my mind amounts almost to a certainty, that the part in these names which comes after the "O" is a proper name, the name of a person; that such names are similar to those we give to localities known principally as the dwelling-places of persons who are well known as residents in such localities. One instance among many may be quoted—"Bulls," at Rangi-

tikei, which, I am sorry to say, is the name which has displaced a much more euphonious Maori one—"Te Arataumaihi." In support of this theory I would mention that I have heard the "Nga" used in many of these names instead of the "O." I have heard Otamarakau, between Maketu and Te Matata, called Ngatamarakau, and the same variation in many other names beginning with "O." If correct, this theory provides a step towards finding the signification of the names of many localities.

Many names of places are common to several localities. We have a Maketu and a Tauranga (Drury) near Auckland as well as in the Bay of Plenty. The "Wairoa" and "Wainui" are to be found everywhere. The place called Akaroa in Banks Peninsula is the same as Whangaroa in the North. The dropping of the aspirated "w," and the change of the "ng" into "k," have altered the appearance of the name, which, as pronounced by the Maoris themselves, is Hakaroa or Whakaroa. "Waitaki" is the same name as Waitangi in the North. Nelson is "Whangatu" changed to Whakatu.

In mutilating and distorting Maori names the settlers in the South are even greater offenders than we in the North. When travelling through the southern provinces of the Middle Island some years ago a Bradshaw which I carried afforded me a great deal of amusement when looking over the names of places supposed to be Maori names. The name in the book could with difficulty only be identified with that given by a Maori resident when I had an opportunity of comparison. I remember one place on a railway-line was called in the book Te Muka, which certainly looked so natural that the probability of error was almost precluded; but this name turned out to have been substituted for "Te Umukaha." Several of the Union S.S. Company's steamers are named after the southern lakes—one after Te Anau Lake. Hearing the name as here pronounced, it did not sound to me like a Maori name. I was curious to find out how it was pronounced by the resident natives, and found that, instead of Te *A*-nau, it should be pronounced Te Ana-*u*, which altogether altered its character. There is another of these steamers similarly named. It is, I believe, generally called the "Monowai." This name also excites my curiosity. A suggestion has been offered that the name is a combination of the Greek "*monos*" and the Maori "*wai*." I am reluctant to accept this explanation, and meanwhile am in doubt as to whether to call the steamer "Te Monowai" as in "monotone," having respect to the Greek element, or "Te Mono-wai" as in "most," which would be the correct pronunciation if the word is really a Maori one.

Exception has also been taken to the retention of Maori names on the ground that the significations of some of them must be classed as unmentionable in refined society. It must be acknowledged that this is true, but I think it is scarcely of sufficient weight to require the relegation of the offending name to oblivion. We have sometimes to speak of matters in referring to which we find it convenient to drop the vernacular and resort to a dead language for words which may be used without offence to ears polite. We are in the daily habit of using words and names without conscious recognition of their derivation or original signification. Many of these offending Maori names also are still, and probably will continue to be, in use in happy ignorance, and furnish instances where "'tis folly to be wise." In others, as in the case of the place called Marton, near Rangitikei, the original name has been banished in disgrace.

In any attempt to trace the origin of the Maori names of places in New Zealand fewer difficulties may be anticipated than would be met with in the case of most other countries. It may be regarded as certain that such names have been given by the Maoris themselves since their coming to these Islands, and are therefore (as names of places in New Zealand) not older than the period during which they have been here—about six hundred years.

Even if these Islands were inhabited by another race before the Maori made his appearance (a supposition which rests on very slight foundation), it is not probable that any of the belongings of such a race could have survived themselves without leaving some trace in Maori tradition. No such trace has been found, and if any older race ever existed their names must have been lost with themselves. The inquirer into the origin and signification of a genuine Maori name will not therefore be baffled by the presence of a foreign element such as would be met with in a similar investigation in the case of a European name.

Johnsonville, for instance: The first step is easy—Johnson's villa; second step, the villa of John's son: but, should we wish to go further, for "John" we must go to Palestine, for "son" to India, for "ville" to France or Rome.

It is more than probable that many of the names given by the Maori to New Zealand localities are those of places in a former home of the race. Others may have been given to preserve the memory of some important event or incident in the life of some person whose name, doings, or experiences are thus handed down to posterity. It was the practice of the Maori in the olden time to compose *waiatas*, or songs, which recited such events, and were sung at public gatherings. They often recounted the famous deeds of an ancestor. Some of

these songs were called "*oriori*," or cradle-songs, supposed to be sung as a lullaby to an infant. One of these will be found at page 89 of Sir George Grey's book, "Poetry of the New-Zealanders." The infant girl is told the story of her ancestor's coming to this land: his name, "Hau"; his voyage in the canoe "Kurahaupo"; landing at Whenuakura, on the west coast of this Island, near Patea; of the building of his house Rangitawi; planting the kumara and sowing the karaka berries he had brought with him, near the sea-shore; then of his taking up a handful of earth, and, with the staff of Turoa in his hand, setting out on an exploring expedition southward, and naming the rivers as they were crossed by him on his journey, the names given to each having some reference personal to himself. Now, whether this song gives a true account of the origin of these names of rivers, &c., or whether the story is made to fit these names, who shall say? I confess myself unwilling to take the responsibility of deciding the question. All I can say is that I believe the *waiata* to recite an accepted tradition, and not a mere legend.

I will now give a short list of names of places where I think the old Maori name should have been retained rather than have substituted for it an English name. In doing so I will give the signification where it is plain, but refrain from taxing my imaginative powers and your credulity by offering a far-fetched interpretation. To begin with our own city. The principal elevations around Auckland are—Mount Eden, Maori name, Maungawhau, Mount of the Whau Tree; Mount Hobson, Remuwera, Burnt hem or fringe; Mount Albert, Owairaka, Wairaka's place; Three Kings, Te Tatua, Girdle or belt; Mount Smart, Rarotonga; Mount Wellington, Maungarei, Mount Tusk; One-tree Hill, Maungakiekie, Mount Kiekie; College Lake, Waiatarua. Rangitoto and Motutapu (Sacred Isle) have retained their names, as also Waiheke, Falling or moving water. Taurarua has been discarded for Judge's Bay; Matahareharе for St. George's Bay; Waiariki for Official Bay; Mechanics' Bay has displaced Waipapa; Horotiu or Te To (doubtful) is Freeman's Bay. Waitemata, though not lost as a name, has ceased to be appropriated solely to the estuary in which our harbour is situated; Te Waihou has had to give place to The Thames; The Great Barrier extinguishes Aotea; Cape Colville, Moehau; Mercury Island, Ahuahu; Mayor Island, Tuhua; White Island, Whakaari.

I will not take up your time further by adding names to a list which might be indefinitely extended.

I have heard that there is a song or lament which was composed to commemorate a very sanguinary conflict which took place somewhere in the neighbourhood of Whangaparaoa, and within view of the island of Rangitoto; that the name it now

bears was given on that occasion, and contains in its signification a reference to the result of the battle. I have not seen this song, and can offer no opinion on the matter. The word "*Rangi*" is the word for "sky," also for "day," and "*toto*" is the word for blood.

As before remarked, it appears fair to give our own names to our own creations—new settlements, townships, road districts, &c., we may properly name; but are we justified in discarding or changing those names which we found here, names which may be said to belong to the land we have come to occupy jointly with its original owners? I see no just cause for depriving Putauaki of its ancient name in order to name it Mount Edgecumbe, nor why hoary old Taranaki should forfeit his name, or exchange it for Mount Egmont. I think "Whanganui a Tara"—the wide bay of Tara—as good and as euphonious a name as Port Nicholson; Ahuriri or Heretaunga as good as Hawke's Bay or the Hutt. I see no sufficient reason for changing Wakaraupo to Port Cooper or Lyttelton, or for substituting Lake Ellesmere for Waihora, Spread-out water; Port Levy for Koukourarata, Tame owl; Stewart's Island for Rakiura; Chatham Island for Whare Kauri or Warekauri, and so on. If the right to give names to places is founded upon discovery, surely we are overstepping ours in changing or altering these names. Most of the mountain-ranges and rivers in the Middle Island have English names, which have superseded the old Maori ones—the Grey and Buller rivers, as instances, ousting Te Mawhera and Te Awatere.

As a means of preventing the old Maori names of places from being quite lost or forgotten, I should like to see an outline map or maps specially prepared upon which the original Maori names of places might be put, when accurately ascertained by careful inquiry, and the sites of old pas and other interesting objects associated with Maori history marked. Such a work might be undertaken under the auspices of the Government, and should not be difficult of accomplishment.

I will now ask your attention for a few moments to Maori names of things. The Maori vocabulary has been greatly enriched, or enlarged, since the advent of the pakeha to Maoriland. A very great many words have been adopted and metamorphosed into Maori shape, and are now used as freely and commonly as if they always belonged to the Maori language. The process of converting an English into a Maori word is not a mere haphazard one. It proceeds upon a fairly regular plan or rule. In turning an English word into a Maori one, very nearly the same shape would be given to it by every Maori who undertook the operation—that is, with very few variations. William would be "Wiremu" everywhere; Frederick would be "Pererika"; a letter "*reta*"; a boot "*putu*"; a steamer

"*tima*"; number "*nama*," &c.: "b's" would become "p's"; "l's" and "d's," "r's." The soft "c" and "s" would be represented by the aspirate, the soft "ch" by "t," and so on. In writing a Maori-ised English word there is no attempt to spell it English fashion; the new word is adopted, assimilated, and treated in every way as a worthy member of the family of Maori words.

It could not reasonably be expected that the language of an uncivilised people should furnish equivalents for the words and names in use among civilised races, nor is it, in my opinion, wise or expedient to force new meanings upon old words—to use them, I mean, to convey ideas which are foreign to their original meaning. A new idea will, I think, be better embodied in a new word, of which the meaning may be taught or explained by the use of many other words. In introducing a new object to a stranger, its proper name should, I think, be introduced with it, in preference to seeking to fit it with a fresh one taken from the stranger's vocabulary. I think, by following such a rule in imparting to the New-Zealanders the knowledge which we, as a civilised race brought into close contact with them, were bound to place within their reach, the work would not have been rendered more difficult, and some inconveniences would have been avoided. The facility with which a Maori picks up and naturalises a foreign word favours the adoption of such a mode of dealing with the problems which arise in the attempt to present to the mind of the uncivilised man the information and thoughts which are the inheritance and possession of civilised men. In illustration of my meaning, I might refer to words and names used by the missionaries in teaching their converts the doctrines of Christianity.

The word taken as equivalent to that which we use as the name of the Supreme Being is "*Atua*," which in its original meaning is used to designate malevolent beings with supernatural powers, to whose agency were attributed all the ills and misfortunes which afflict human beings, whose powers were invoked only to injure an enemy, who hated mankind, and who were ever on the watch for opportunities of wreaking vengeance upon the unfortunate mortal who wittingly or unwittingly gave them umbrage. Their powers were restrained, controlled, and directed by *tohungas*, by means of incantations, some more and some less potent or efficacious.

Again, the words taken for worship, spirit, heaven, hell, hope, conscience, baptism, and others, are words which, until the new significations with which they are arbitrarily invested are learned and become familiar, certainly do not signify the same things as do the words for which, as equivalents, they have been used.

With respect to the word "*atua*," I do not, of course, refer to the *atuas* of Maori mythology, which may, I think, be regarded as mere fanciful personifications of the manifestations which we call natural phenomena, and not as the names of sentient beings who are concerned with human affairs, or anything more than the objects appearing and forces operating in the visible world. Some are names given to mere abstractions—vacancy, darkness, light, &c.; others, inanimate objects —sun, wind, storm, &c. The *atua* known to the Maoris as having present personal relations with human beings was a malignant being. In the case of His Satanic Majesty the other mode has been adopted: the word "Devil," *Rewera*, and the name "Satan," *Hatana*, have been naturalised in Maoridom, and are as well known throughout New Zealand as any word of purely Maori origin.

The Maori scholar is often puzzled by coming across a word which looks like a Maori word, but which is an utter stranger to him. Its meaning is sought by examining it critically and comparing it with other words apparently similar. Nothing beyond a guess can be arrived at. At last he finds out that the word is an old acquaintance unrecognised in its Maori dress. For example, I once heard some natives using the word "*koroa*" in reference to sudden deaths which had occurred. I could not think what the word was till one of the natives said I ought to know, as it was a pakeha word, and then I found it was our word "cholera," which they had heard used by Europeans, and supposed to be the cause of these deaths. I could give many other instances of Maoriised English words which on first appearance proved very puzzling.

It must not be supposed, however, that the Maori language is deficient or lacking in respect of words to designate with clearness and precision the things which appertained to the life and surroundings of the aboriginal New-Zealander in his somewhat circumscribed world. He had words for each of the twenty-nine days of the lunar month, for the seasons, the heavenly bodies, birds, beasts, fishes, plants, social relations, passions, sentiments, rude art. Everything, in fact, coming within the scope of his intelligent observation had an appropriate word by which it was designated.

The nicest distinctions were marked by different words which in translation are generally rendered by the same English word. The Maori has as many (or more) names for the head as we have, and each embodying a different idea. "*Upoko*" is the principal word used as the name of the head, but the idea is very different from that conveyed by the use of another word, "*mahunga*," also meaning head. "*Upoko*" is used charily—the idea of the *tapu* or sacredness is present

when it is used. In common with our word "head," it is used to express supremacy, prime authority. In the word "*mahunga*" these ideas are absent, the main idea here is of hair—the poll, in fact. "*Matenga*" is another word also meaning head, and is used more frequently than "*upoko*" when speaking of another person's head. The idea attached to this word is not the same as that of either of the two other words. There are several other words for the head—"*angaanga*," equivalent to our "skull," "*pane*" or "*panepane*," "*pareho*," "*uru*"; and there are others answering to our jocular names—"*takataka*," "noddle," &c. The mouth has also several names, but each differing in signification. One Maori word for mouth is "*mangai*," but here the presence of the dissyllabic root "ngai," which is also found in the word "*whangai*" (to feed), suggests the idea of the mouth as an eating-organ. Another word for mouth is "*waha*," which is also the root of words signifying a door or opening, and carries with it the idea of, and is appropriate as, designating the passage for words. Hence, a "*wahangu*" is a dumb person, out of whose mouth no words come. The Maori word for speech is "*korero*," and for the tongue "*arero*." "*Reo*" is the voice. The head of the *taiaha* (Maori weapon), which is a protruding tongue, is said to "*purero*," or protrude, as the tongue. "*Purero*" is also to appear above the surface of water—to float after submersion. "*Korero*" is thus seen to be a word cognate with the other words "*arero*," "*reo*," and "*purero*," and to carry the idea of that organ of speech which is also protruded as a defiance from the mouth, and from the head of the *taiaha*.

Once more: The word for leg and for foot is "*waewae*." *Wawae* is to divide, *kowae* also. *Waenga*, or *waenganui*, is the middle, or midway, between divided portions. *Kauwae* is the lower jaw, where the face is divided. The root "*wae*," present in all these words, shows that the idea of division is common to all, and that the idea in "*waewae*" is really the parting or division of the body into two limbs.

I fear that the remarks to which you have so kindly listened this evening have been of such a discursive and desultory character that I may have exhausted your patience without exhausting or even doing justice to my subject. I will therefore now close them with an apology for shortcomings, and sincere thanks for your kind indulgence while permitting me to occupy so much of your time and attention.

Art. LVII.—*The Extinction of the Moa.*

By Edward Tregear, F.R.G.S., &c.

[*Read before the Wellington Philosophical Society, 24th August, 1892.*]

In the lately-issued volume (vol. xxiv.) of the Transactions of the New Zealand Institute appears a paper by Professor Hutton, F.R.S., on the subject of the moa. It is an admirable monograph, evidently prepared with the intention of exhausting the arguments by collating and comparing the views of different writers on the subject. The geological, zoological, and traditionalist writings have been brought together, and leave little to be desired in regard to these branches of inquiry. Professor Hutton's article, however, has the merit or demerit, in my eyes, of not having taken notice that there still remained one line of investigation unexplored. I speak as if in doubt as to the merit or demerit of this course because I feel that it would have been of advantage to us had he used his great powers of observation and scholarship on this as on the other elements of his literary production, while, on the other hand, his not having done so leaves the way open for again discussing the matter. The line of inquiry which I refer to as neglected hitherto has been that of *comparative* philology. I lay stress upon the word "comparative," because the matter has been treated in somewhat of a philological manner by reference to place-names, &c., in which the word "moa" occurs. But comparative philology tells us that if we want to find out the meaning of a native word we must not only ask what the New Zealand Maori means by it, but whether his brothers, the Polynesian Maoris, use the word, and what they mean by it. Nay, more, whether the black people spread through the thousand islands of the Pacific know the word, and to what particular objects the word is applied by them.

I have already written on this subject, and that my paper has not been noticed by Professor Hutton is owing to the circumstance that he has sought for his local authorities and traditional evidence in the pages of the Transactions of the New Zealand Institute. My paper was contributed to the Anthropological Society of Great Britain, and the arguments it contained were only brought forward here by me in the course of a discussion which ensued on a paper by Colonel McDonnell as to Kawana Paipai having hunted the moa in recent times on Waimate Plains.* I had not the right of reply on that occasion, so was obliged to allow the arguments of my oppo-

* Trans. N.Z. Inst., vol. xxi., p. 438.

nents to remain unanswered. To prevent the comparative-philological line of inquiry being again overlooked, I have resolved to put it on record in the pages of the Transactions, if space is kindly allowed to me. Moreover, some years have elapsed since I wrote the former paper, and I have now more knowledge of the subject than at that time.

To my view, the present position of the argument stands thus: The geologists and zoologists have gathered together certain facts, which they have embodied in their papers on the subject. Those who may be called "the traditionalists" have no possible pretence for attacking these facts; the evidence is unimpeachable, and stands "foursquare to all the winds that blow." But, if the natural scientists leave the solid standing-ground of facts, and begin to theorize, then they leave their entrenchments, and are open to the attack of many assailants. To exemplify, so long as the geologist states, "I have found the bones of the *Dinornis* in such-and-such positions; I have found the egg-shells and the feathers thus and thus," then he is in a safe and impenetrable position. But if he leaves his shelter, and says, "Because the bones are found in quantities on the surface of the ground and in swamps, therefore the Maoris must have known the *Dinornis*, and they called the *Dinornis* the 'moa,'" then it is open for the traditionalist to answer, "I doubt this very much," and for the philologist to say, "That is improbable." When a geologist states, "We have found neolithic weapons and tools, together with *Dinornis* bones, in native ovens," he is within his own lines; but if he comes forward and remarks, "Because polished-stone weapons are found in encampments of *Dinornis*-hunters, therefore the Maoris slew the *Dinornis*, by them called the 'moa,'" then the archæologist or ethnologist is at liberty to say, "You are travelling outside your position, and I shall meet your assertion as to these weapons having belonged to ancient Maoris by the counter-assertion that the weapons belonged to the ancient Irish or the ancient Danes, because little difference can be found between the neolithic implements and weapons of diverse races, and neither assertion can yet be proved." This, then, is the present position: a waiting in order of battle, with here and there a skirmish, but the fate of the day yet undecided.

I need not rehearse at any length the arguments used by geologists and zoologists; they can be found in references by consulting Professor Hutton's paper, and at full length in easily-procured volumes. Briefly, the record stands thus: The bones of hundreds of specimens of different species of *Dinornis* have been found both in the North and South Islands. At Hamilton and Glenmark they were found in swamps. In Te Aute Swamp the leg-bones were discovered in a vertical

position, as though the birds had perished standing. At Glenmark and Hamilton they were in all positions, as though washed down by a flood, but they were not waterworn. In some places the bones were discovered where rivers debouch on the plains. Other bones have been found on the sites of encampments, and with these have been found flake-knives of chipped stone and instruments of polished stone; in a few places the instruments are of polished greenstone. Sir James Hector, Dr. Von Hochstetter, and Mr. F. Chapman all testify to the fact of bones being found in large quantities on the surface of the ground; even the cartilage, skin, and tendons have been preserved on leg-bones and vertebræ. Egg-shells, and eggs enclosing the bones of the young chicks, are now in our museums, and it appears natural enough that a number of adherents should be found to the theory which has been set forth, that the evidence is all in favour of recent extinction, and that therefore the Maori, in his allusions to the moa, must refer to the *Dinornis*. However, two naturalists—viz., Dr. Von Haast and Professor Hutton—demur to consider the theory proven.

On the other hand, I will sum up, also as briefly as possible, the argument of the traditionalists. They say that had the Maori known the *Dinornis* it would have left an ineradicable record upon their songs, legends, proverbs, &c. That, while in their mythological tales there are accounts of combats with monstrous *taniwha* (lizards or crocodiles), with cuttlefishes, with ogres, with flying-birds, there is no story telling of battles between any god or hero and the moa. That, whereas in the descriptions of the chiefs taking possession of new country all articles of food are mentioned in full detail—parrots, pigeons, tuis, kiwis, eels, even rats—there is no notice taken of the huge food-producing bird. That, although we have incantations and hunting-charms for killing all manner of creatures,—charms recited from priest to priest and from father to son for centuries,—there are no charms for killing the moa. That, while they mention all kinds of pet animals, even the great man-eating lizard of Tangaroamihi, and the pet whale of Tinirau, there is no mention of the moa being tamed (except in one story by Sir Walter Buller, which is alluded to further on). That, while the Maoris possess many precious garments handed down through generations as heirlooms—mats of kiwi- and albatross-feathers, of dog-skins, &c.—there are no mats of moa-feathers. That in the ancient songs and proverbs the word "moa" is very seldom met with, and then something in this manner: "Lost as the losing of the moa," without specifying what kind of creature the moa was. I may add to the usual argument here by saying that, if *moa* meant *Dinornis*, it would probably

have given birth to some adjective meaning "large"; a proverb would have been formed—"Huge as the moa," "Lost like the losing of the gigantic moa," or something of the kind; but, so far as the legendary mention goes, the moa might have been the size of a sparrow. To try to obtain any information from natives at the present day concerning the moa is to court error; but when the old chiefs in the North Island were asked, half a century ago, what they knew of the moa, they replied that neither they nor their forefathers knew the moa, for the last moa was destroyed in "the fire of Tamatea"—*i.e.*, in far-away mythological times. Lest this should be thought only to relate to the North Island, I would point out that the Rev. Mr. Stack, our authority on the South Island Maori, denies that the Maori knew anything of the *Dinornis*, and shows that the saying "Lost as the moa is lost" is to be found in one of their most ancient songs. The Rev. Mr. Wohlers, also, the South Island missionary, collected forty years ago a great variety of legends, and, although these mention seals, whales, dogs, herons, owls, rats, &c., no word concerning the moa appears in them. Mr. John White, in his "Ancient History of the Maori" (vol. i., p. 181), relates the tradition of the South Island priests, that the moa was destroyed in the days of the Deluge. The Rev. Mr. Colenso was informed, half a century ago, that the last moa was to be found on the top of a certain hill, guarded by two great lizards.

These accounts seem to remove the moa into the land of pure myth, and into the antique times wherein myth has its natural abode. I cannot accept the evidence given by Judge Maning, by John White in his earlier writings,* by the Rev. R. Taylor, or by Colonel McDonnell, as to the stories told by natives concerning the habits, &c., of moas, when compared with the evidence given to Mr. Colenso and to Mr. Stack as to the traditional extinction of the moa in the days of the Deluge. I must not omit to mention that Sir Walter Buller, being in London when my first paper was read, supplied a note to the paper in the Transactions of the Anthropological Society, in which he stated that he had heard a legend related that a certain chief a long time ago had been lamed by the kick of a pet moa. However, Major Mair, in conversation with me, declared that the chief who was thus lamed was a demi-god, not a man, and that he had split open the earth

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* Mr. Colenso disposes (vol. xii., p. 104, of Transactions) of Mr. White's assertion that a moa had been killed in modern times near Waipukurau by stating that he (Mr. Colenso) had been living at Waipukurau for forty years, and had not heard of the circumstance; also, that he had there conversed with Maoris who had known Captain Cook, but knew nothing of the moa. Mr. Colenso adds that he knew Mr. White when the latter came, a boy, to New Zealand.

into a valley with a blow of his heel. By a fortunate coincidence, Sir Walter is now President of this Society, and will be able to give us particulars of the story. The bird spoken of as the gigantic man-eating bird of the South Island was a mythological winged bird—the pouakai, not the moa. I think that we may dismiss as idle tales, told by persons loving notoriety more than truth (whether white men or Maori), those stories in which the narrators relate that they have seen or hunted the moa in our own days. Even of those most ancient words, the names of places, the incident seems to be unknown, for, when reliable chiefs were asked (see Trans., vol. xii., p. 97) the reason why certain place-names contained the word "moa," they answered, "Our ancestors themselves did not know, and so that want of knowledge has come down to us, and is with us of the present day."

I have endeavoured to give the main arguments used by the naturalists and by the traditionalists. To turn to the philological view, this has not been utterly neglected. Mr. Colenso long ago called attention to the fact that "moa" was the name of the domestic fowl in Polynesia, and Professor Hutton notices the point in a note (vol. xxiv., p. 157). But the subject calls for a great deal more consideration than a mere reference. The question with which we have to deal is this: When proverbs, place-names, and verses from old songs in which the word "moa" occurs are cited as evidence that the Maoris knew the *Dinornis*, is it absolutely certain that they were referring to the *Dinornis* in any way? Not a single quotation describes one peculiarity of the creature named, and we are left to look elsewhere for evidence which may or may not connect the moa with the *Dinornis*. This evidence must be sought outside New Zealand.

The philological evidence is doubtless very dry and technical, but I must try the patience of those interested in the subject by treating it in an exhaustive manner, even if it exhausts my audience.

If *moa* means in Polynesia the domestic fowl (*Gallus*), let us first inquire if it be the general name, or if there is any other. In the dialects of New Guinea we find—in Bula'a, *kokoroko*; Nada, *kokoreko*;* Sinaugolo, *kokorogu*; Nala, *'o'oloko*—all meaning the domestic fowl. In the Solomon Islands—Guadalcanar, *kokoroko*; New Georgia, *kokorako*; Bougainville, *kekeleo*—all meaning the common fowl. In the Caroline Islands we find, at Eddystone Island, *kokeraku*, a fowl. It may be that the variants of this word *kokoreko*, a fowl, may be "sound-words," similar to the Malay of Macas-

* I may mention that in the Paumotus *reko* is "the voice," and equals the Maori *reo*.

sar, where *koko* means "to cackle," and the Tamil of India, in which *kokkarikkirathu* means "to cackle"; but if we consider the Spanish word *cacareo*, the crowing of a cock (Portuguese, *cacaraca*, the clucking of hens), and that the Spaniards were early discoverers of these islands, it appears probable that the natives may have adopted the Spanish word. As the locality where this word obtains is very circumscribed, and not inhabited by fair Polynesians, the point is only of secondary importance.

The next word for the domestic fowl in Oceania which we will consider is *toa*. Its meaning and distribution is as follows:—

New Zealand—

Toa, the male (of animals). (2.) Victorious. (3.) A brave man, a warrior. (4.) Courage. (5.) Success obtained by courage. (6.) To throw up a stalk. (7.) To romp, to gambol.—*Totoa*, impetuous; fierce. (2.) Urgent, pressing.

Samoa—

Toa, a warrior. (2.) A cock, the male of the domestic fowl. (3.) The ironwood tree (*Casuarina*).—*Fa'atoatoa*, to bear patiently; to endure.

Tahiti—

Toa, a warrior, a valiant man. (2.) The ironwood tree. (3.) A stone, a rock.—*Faa-toa*, to crow together. (2.) To make courageous or warlike. (3.) To stir up mischief.—*Faa-toatoa*, to be very brave. (2.) To make exertions too soon after sickness.

Hawaii—

Koa, a soldier; an army. (2.) Brave, bold, to be courageous. (3.) The horned coral.—*Hoo-koa*, to be valiant.—*Koakoa*, brave, daring, impudent.

Tonga—

Toa, courage, courageous. (2.) The name of a tree.—*Faka-toa*, to show courage.

Marquesas—*Toa*, a warrior. (2.) A male. (3.) Brave. (4.) The ironwood tree.

Mangaia—*Toa*, a warrior. (2.) The ironwood tree.

Mangareva—

Toa, to be brave, strong. (2.) The ironwood tree. (3.) Female.—*Toatoa*, valiant. (2.) To work fast.—*Aka-toa*, vehement in speech. (2.) To be valiant. (3.) To be industrious. (4.) To make an effort.

Easter Island—*Matatoa*, a victor.

Paumotu—

Toa, brave, valiant. (2.) In good health. (3.) To triumph.—*Faka-toa*, ambitious.—*Faka-toatoa*, to disdain.

Fiji—

Toa, a fowl.—*Doa*, the heart of a tree.

Melanesian: Futuna—*Toa*, to fight. (2.) The ironwood tree.

Efate—*Toa*, the domestic fowl.

Malo—*Toa*, the domestic fowl.

S.E. Api—*Toa*, the domestic fowl.

Sesake—*Toa*, the domestic fowl.

Pentecost—*Toa*, the domestic fowl.

Espiritu Santo—*Toa*, the domestic fowl.

Lepers' Island—*Toa*, the domestic fowl.

We have here a word of far wider distribution than *kokoroko;* but it is of peculiar distribution. In Polynesia the wide meanings are—(1) Brave, victorious; and (2) the ironwood tree. I consider that this is a case where the etymology is plain, and, although it is undesirable to give etymologies in the present state of knowledge concerning Polynesian, this word *toa* is an exception. In making comparison between words in Maori and those in the dialects of Eastern Polynesia, it is an almost invariable rule that when two vowels come together in a word a lost "k"* must be "read in." Thus *pio* is the Maori *piko; ai* is the Maori *kaki*, &c. This being the case, it appears probable from analogy that we should, in reading Maori itself, view with distrust the conjunction of two vowels, and inquire if a lost consonant should not be supplied. If we do this to *toa* we find that *toa* should be read *toka*. Now, *toka* in Maori means a stone, a rock; (2) to be subdued, stilled: *totoka*, to become solid; to congeal as ice or fat. This is followed by Tahitian *toa*, a stone; a rock; coral-rock: Hawaiian *koa*, the horned coral: Marquesan *toka*, the white coral; Samoan *to'a*, to congeal, to coagulate; a rock. But *toka* in Maori is but a form of *tonga*, the south; snow; biting cold, &c. Thus we may trace the different forms, *tonga*, *toka*, *toa*, as—Bitter cold; to set, as ice; a rock; white coral-rock; hard; the hard ironwood tree; the hardy warrior; the valiant fighter; the fighting-cock; for, as I shall show further on, the fighting-cock was as much the emblem of courage in Polynesia as in Europe. The Polynesians generally, however, have not received *toa* as the domestic fowl, with the exception of Samoa (which has had much intercourse with Fiji), and we find that it is over a Melanesian area that this word as "the cock" is in use—viz., in Fiji and the New Hebrides.

We now approach our important word *moa*, the Polynesian for the domestic fowl. To consider this properly it is well to divide the meanings of the word into two classes—viz., those

* Or "ng," which is a form of "k." In Rarotongan "h," or "wh" must be supplied; in Marquesan, a lost "r."

that apparently have no "bird-meaning" and those that have. Of course some of these apparently unimportant words may hereafter be found to have a vital connection, but it is more easy to keep the words concerning the bird in mind if we strip away into a separate division those meanings which do not appear to have direct relationship.

The meanings of *moa* not related to the bird-meaning are as follows:—

New Zealand—

Moa, a kind of stone or stratum of stone; ironstone. (2.) Petrified wood. (3.) A garden-bed, land having divisions between, small prominences like garden-beds. (4.) A kind of drill for boring hard stones. (5.) A species of coarse sea-side grass (*Spinifex hirsutus*). (6.) To jump forward, to jump up, to ascend. (7.) To oscillate, to swing.—*Moamoa*, small round shining stones, like marbles.—*Whaka-moa*, to lay in a heap.

Samoa—

Moa, the end of a bunch of bananas. (2.) The fleshy part of the *alili* (a mollusc). (3.) A child's top. (4.) The epigastric region. (5.) The middle, as of a road or river.—*Moamoa*, full-grown. (2.) The name of a fish. (3.) A piece of cloth used to take hold of a fish with.

Tahiti—

Moa, the name of a species of fern. (2.) A whirligig made of the amae seed. (3.) A bunch of miro leaves used in the sacred place.—*Momoa*, to espouse or contract marriage. (2.) Long and narrow, applied to the face. (3.) The ankle-joint. (4.) The knuckles. (5.) To make sacred, to put under a restriction.—*Haa-moa*, to make sacred.—*Haa-moamoa*, to observe the former customs as to sacred places and persons, restrictions regarding food, &c.

Hawaii—

Moa, the name of a stick used in play. (2.) The name of a plant. (3.) The name of a piece of wood on which to slide downhill. (4.) A kind of moss. (5.) A variety of banana.

Marquesas—

Moa, a priest of the secondary rank.

In regard to one of these meanings in Maori, I have included it in the list of words unrelated to the bird because the form is doubtful. The Hawaiian word is *moo*, a garden-bed; a division made for irrigation; any planted patch of food, provided it be much longer than it is wide. And this variation brings to notice that both *moo* and *moa* in Hawaiian mean to

become dry or cooked. A Tongan meaning of *moa* is dry or dried, so is Marquesan *moa*, cooked, and *pamoa*, cooked on the coals. If we had not the Maori comparative, *mamoa*, cooked, it would almost appear as if the Polynesian words were not related to Maori *moa*, but to *maoa*, cooked.* Before I leave these words I beg to draw attention to a compound word in Samoan—viz., *samoamoa*, " dried up as a fish often cooked, or a skeleton on which the flesh is dried up." As a mere hypothesis, I venture to suggest that if the Polynesian Maoris ever knew the *Dinornis*, and called it *moa*, it was because they saw it as " a skeleton on which the flesh is dried up."

I now turn to the words in which the meanings probably refer to some sort of bird. I also give the compound words, as they tend to show distinctly the character of the creature.

Samoa—

Moa, the domestic fowl; *moa'aivao*, a wild fowl.

Tahiti—

Moa, the domestic fowl, (2) long and narrow, applied to the face. *Moafaatito*, a fighting-cock; *moahururau*, a fowl of many qualities, (fig.) an unsteady or fickle person; *moaopapa*, a fowl without a tail; *moapateatoto*, a courageous cock, a stern warrior; *moaparuhi*, a cowardly cock, a cowardly warrior; *hihimoa*, the feathers on the back of a fowl's neck; *moataratua*, a cock with a long spur, (fig.) a bold warrior; *moaraupia*, a peculiarly-coloured fowl; *moataavae*, a fowl tied by the leg; *moatautini*, a cock that beats all opponents; *moavari*, a cock; *fauparamoa*, a head-ornament of feathers; *huamoa*, an unfledged chicken; *maimoa*, a toy, a pet, favourite; *matamoamoa*, a thin, narrow face; *moarima*, one finger hooked into another finger; *raemoamoa*, a prominent sharp forehead.

Hawaii—

Moa, the domestic fowl; *moamoa*, to be or act as the cock among fowls, (2) the sharp point at the stern of the canoe; *hoo-moamoa*, to go in company with, as a cock goes with hens to give warning in case of danger, to be intimate with; *moaoua*, a young cock before his spurs are grown; *moakakala*, a cock with sharp spurs; *moakinana*, a hen that has laid eggs; *moamahi*, a cock that conquers, a conqueror of any kind; *moawi*, a poor fowl; *ahamoa*, the name of the assembly met together at a cock-fight; *hakamoa*, cock-fighting; *huamoa*, a

* Hawaiian and Tahitian have also the word *maoa*, meaning " dry, hard, ripe," while Maori has the form *maoka*, with same meaning as *maoa*.

hen's egg, the round bone that enters the socket of the hip; *koomoa*, the long feathers in a cock's tail.

Tonga—

Moa, the domestic fowl; *moatane*, a cock.

Mangaia and Rarotonga—

Moa, the domestic fowl; *atamoa*, a ladder.

Marquesas—

Moa, the domestic fowl; *aka-moa*, to preserve, to take care of; *tomoa*, encouragement to fight given by two spectators.

Mangareva (Gambier Islands)—

Moa, the domestic fowl, (2) to make a hole in the ground, to dig up; *moaga*, a red beard.

Paumotu—

Moa, the domestic fowl; *maimoa*, a plaything, a pet.

Melanesian: Futuna—

Moa, the domestic fowl.

Easter Island—

Moa, the domestic fowl.

Now, in these words we have not only a plain proof that *moa* was the common word in Polynesia for the domestic fowl, but in its very wide geographical distribution (from the New Hebrides to Easter Island) we may feel sure that the word is not newly introduced, but is an ancient name probably known to all Polynesians before their dispersion. Moreover, it is a fact in regard to language that words taken in bodily from a foreign tongue seldom "make growth" like the native words. Of course, I do not allude to wholesale interpolations like the Norman-French forced on the Saxons at the time of the Conquest, but to odd words brought in "to fill a long-felt want." Thus, the English tongue may adopt words like "chaperon," or "tattoo," but they remain as single words, and do not readily form compounds; while a genuine English word like "hair" forms "hairy," "hairless," "hair-breadth," "hair-spring," &c. As I have shown above, the word "moa" has made an enormous quantity of compounds in some dialects, and these compounds show unmistakably the character of the animal. Can we dream that when the Tahitians or Hawaiians are using words which mean "a fighting-cock" or "a long-spurred cock," as figures of speech for a valiant warrior, they are alluding to the *Dinornis*, which certainly did not fight with its spurs?

It may be objected that, although the Maoris are Polynesians, and may be expected to know the word *moa* as all other Polynesians did, the compounds showing it to relate to the domestic fowl only were constructed after their separation from other tribes. Let us, then, examine some of

the compound words in Maori, and see what evidence they produce. We have a word, *maimoa*, which means a decoy-bird, and a pet or fondling. As "a pet" the word is thus found also in Tahiti, Tonga, and the Paumotus. Mr. Colenso says that *mai-moa* is a good name for a decoy, as it means "come hither, moa," which is undoubtedly the right translation, if we shut out the notion of it being the *Dinornis* which was coaxed to come and be a pet. *Mai*, which in Maori, Tongan, and other pure Polynesian dialects, means "hither," is used as the verb "to come" in Aniwa, Motu, Pellew Islands, Sula, and other Malay and Melanesian localities. But when combined with *moa* it will be well to consider the example given in Lorrin Andrews's Dictionary of Hawaiian. He says that *mai mai* means to call one to come; to invite towards one; to call, as one calling chickens; and the example is, *e kolokolo aku i ka moa*, to call fowls. So that *mai-moa* is to call fowls, not to call the *Dinornis*.

Our next Maori compound-word is *taramoa*, or *tataramoa*, the bramble or "bush-lawyer" (*Rubus australis*). This is a plant armed along the under-sides of the leaves and stems with sharp recurved spines. Now, *tara* means a point, as a spear-point; *taratara*, a spine, a spike, a thorn. In Tahiti *tataramoa* is the name of a prickly shrub; in Tonga, *talatala-amoa* is the name of a prickly shrub, and also in Samoa; *tara*, or *tala*, meaning a spike, a thorn. But in Tahiti *tara* means more: it means a cock's spur; and, while *tataramoa* means a prickly shrub, *tarataramoa* means the spurs of a cock. So also in Hawaii, where *kakala* ("k" for "t"—*kakala* is *tatara*) means sharp, sharp-pointed; it also means the spur of a cock; and *moakakala*, a cock with sharp spurs. To add to this, we find in Hawaii that *moamoa* means the sharp point at the stern of the canoe. Thus, then, these compounds plainly state two facts: First, that the Polynesians had a common name for prickly shrubs before they separated—a name known to the Tongan and Tahitian, as to the New-Zealander—and that this name was given to such plants as had spines like the spurs of a cock. Consequently, the Maori once knew the cock as *moa*.

The third compound word is *tautauamoa*, defined in Williams's New Zealand Dictionary as being a quarrel in which few take part. *Tau* here evidently means "to attack," as in *taua*, a war-party. Mr. John White says (Trans., vol. viii., p. 80) that a battle in which there are a number of single combats going on is called *he whawhai tautau a moa*, a fight, two and two, like the moa. If we try to find this word in other dialects we may turn to Mangaian, wherein *taumoamoa*, to contend for a prize, is only used in the dual; and to Samoan, where we find *fa'a-moataulia*, "to provoke

a quarrel of two, as of two cocks." Our "quarrel in which few take part" turns out to be a cock-fight, and to have nothing to do with the *Dinornis*.

The last word necessary to mention is the Maori word *whaka-toamoa*, "an insulting dance used to incite warriors to deeds of bloodshed." We need only consider how *toa*, used as "to be valiant," and *whaka-toa*, "to incite, to stir up," is common in Polynesia; how *toa* is the domestic fowl in some islands, and how the Tahitian *faa-toa*, "to crow together," also means "to make warlike," to understand how the Maori dance, used to incite to deeds of bloodshed, has this extraordinary combination of the two words for the fighting-cock—viz., *toa* and *moa*.

I have thus, then, covered as nearly as possible the field of knowledge concerning the comparative value of the word *moa*, so far as our present acquaintance with Polynesian dialects allows a student to do.

In conclusion, I would suggest it to be desirable if we could look at this question for awhile through a more impersonal medium. We have become so used to view the subject from one side or the other, to examine it so constantly through the spectacles of one learned man or another, that our conclusions receive a continuous personal or local colouring. I will appeal to your imaginations, and ask you to consider the locality of argument shifted. We will suppose ourselves for a little while on some unnamed island. It is inhabited by a people who speak our own English dialect of Low Dutch, but they have no written records. They are known by tradition to be immigrants to the island, and they have no quadruped larger than the rat. Some scientific men visit them, and find *in sitû* the bones of mammoths. On appealing to the natives, the scientists are informed that these must be the bones of a creature called "the hound"; that it is mentioned in a few verses of very old songs and proverbs, such as "Lost like the losing of the hound"; "Lost as the hound has been lost"; but their old men add, "Neither we nor our fathers ever saw the hound, because the hounds were all destroyed at the time of the Deluge." The geologists and naturalists say to them, "You must have known this creature (the mammoth); its bones are found on the very surface of the ground; nay, with sinews and integuments still adhering." The traditionalists and the naturalists are at strife, unable to reconcile the legends with the (apparently) recent destruction of the animal. The philologist then steps forward and says, "It may be true that the natives once called the mammoth 'the hound,' but let us go outside the island, and see if we can find traces of the name 'hound' among the brothers of these natives, among men who speak dialects of the one Teutonic

language." He goes outside the island; he finds that in one place "hound" means "dog," in another place the same; wherever he goes he finds that "hound" is equivalent to "dog." Then, he meditates, "It is possible that the islanders may be mistaken, and that 'hound' never was the name of the mammoth. Their songs say nothing of 'the huge hound,' 'the flesh-producing hound:' it may have been the dog itself which was alluded to. Let us try the compound words." He does so, and finds that a word which is being interpreted "Come here, mammoth!" should be, "Come here, dog"; that the word rendered "mammoth-fight" should be "dog-fight," since the words are still so used among sister peoples which never lost the hound. He finds that the compound words exhibit attributes which refer to the dog only, which could not refer to the mammoth, and which prove that the islanders once knew the dog as "hound." In a similar manner I have proved to you that the word "moa" and its compound words prove that "moa" is not the mammoth of birds, the *Dinornis*.

There is yet one point unconsidered. Having known the moa as the domestic fowl, did the Maori bestow this name on the *Dinornis?* The Maori has been recognised as having more than ordinary powers of acute observation, and he possesses a copious and flexible language. Is it possible that he named the huge grey *Dinornis* from its likeness to the barn-yard cock? It is most improbable, and would say little for either his observation or power of linguistic expression. I have heard a suggestion that on coming here he was so impressed with the sight of the *Dinornis* that he called it "the" bird, *moa*. But *moa* does not mean "bird"; *manu* is the general name for bird; and, although we may speak of "*the* man of men" in English or Greek or Hebrew as a pre-eminent distinction, we could not do so in Polynesian. We must also remark that tradition bears strong evidence that the moa is a reminiscence of the cock. Mr. Colenso says (Transactions, xii., p. 64) that half a century ago, when he was making his inquiries concerning the moa, he was told that "in general appearance it somewhat resembled an immense domestic cock." Again, the traditional feather handed down from generation to generation as a moa's feather was "bright and shining, like the plume of a peacock"; but, then, this feather had been found in a tree, not taken from the bird. It was evident that it was not the dull grey plume of a real *Dinornis*, it was only that the traditions telling of the bright (cock's) feathers of the moa made the natives think that they had found a plume of their lost bird.

I do not claim for an instant that this paper has settled the controversy as to whether the Maoris did or did not know

the *Dinornis*. But I think that those who have considered the arguments adduced will agree with me that we have cleared away a good deal of what has been supposed to be evidence to that effect. We have seen that it is in the highest degree doubtful whether the allusions in place-names, songs, proverbs, or legends to the moa refer to the *Dinornis* in any way, so that in the future we may discuss the relation of the *Dinornis* to the Maori without knowing the Maori name of the *Dinornis*, any more than we know the Maori name of the extinct swan whose bones were found together with those of the *Dinornis* in the cave at Sumner.

Art. LVIII.—*On a Maori* Waiata.

By R. C. Bruce, M.H.R.

[*Read before the Wellington Philosophical Society, 5th October, 1892.*]

The following Maori *waiata*, or song, has a somewhat interesting history, and is worthy of preservation. It alludes to districts on the West Coast which, antecedent to the advent of Europeans, have been, amongst the natives, the theatre of great events. And as the years roll on such legendary lore will become more valued. It is calculated to fling a halo of interest and romance over a country which will in the future have no other history of the ages prior to the arrival of the Anglo-Saxon race. The story of the song is briefly as follows: The territory of the Ngatiapa Tribe extended from the Manawatu River on the south to the Wangaehu on the north; that of the Muaupoko, from Manawatu southwards to Pukerua, and also embracing the Island of Kapiti. The Ngatiapa Tribe were attacked by the celebrated warrior-chief Te Rauparaha, aided by allies of the Ngatiawa and Ngatiraukawa Tribes from Kawhia, Taranaki, and Waikato. The Ngatiapa had, fortunately, as their chief, one who in war and diplomacy was even more than a match for Te Rauparaha, and who, by the exercise of those qualities, succeeded in preserving his tribe from extinction. This was Te Hakeke, of whose prowess many traditions still linger amongst the tribes of the West Coast. His wife, Kaewa, was a woman of high rank in the Muaupoko Tribe, which, in spite of her husband's exertions, was almost annihilated by Te Rauparaha and his allies. On the birth of their child, Te Rara-o-te-rangi (rib of the sky), Te Hakeke took

the infant in his arms, and, carrying him along, composed his song, dedicating the boy to the recovery of the tribal lands of his maternal ancestors. The hokioi alluded to in the song is a bird which finds a place in Maori legendary lore, and is said to have been a gigantic bird of prey of the eagle species, but of much larger size. "Its resting-place was on the top of the mountains; it did not rest on the plains. On the days on which it was on the wing our ancestors saw it; it was not seen every day, as its abiding-place was on the mountains. Its colour was red and black and white. It was a bird of (black) feathers, tinged with yellow and green; it had a bunch of red feathers on the top of its head. It was a large bird, as large as the moa." This tradition, of which the foregoing is a translation, was given to Sir George Grey by a Maori chief of the Ngatiapa Tribe.

It receives in some degree confirmation from the discovery in the Middle Island of the bones of a gigantic bird of prey, which probably fed upon the moa, and disappeared when the birds which constituted its food ceased to exist.

THE SONG.

Kate, e tama, te noho ki to whare;
E puta ki waho ka haere taua
Ngaparae i waho o Whakaari.(1)
E uia mai koe kowai te ingoa,
Mau e ki atu, Ko te Rara o te Rangi.
Kei ki mai te wareware,
Ka pau te whakanoa e te tini, e te mano.
Naku ia nei na te kahui pepe te roa wai rewa.
Kei hea te Tupuna hei whakawehi mai i muri ano Whakataupotiki,
Nana i tautoko te rangi i runga.
Ka puta koe ki te whaiao
Ki te ao marama.
Hikaka te haere ki runga Taikoria,(2)
Pukana o karu ki roto Manawatu;
Kei o matua e tu mai ra i te one o te riri, ka kore he tangata.
Aro nui te haere ki roto Horowhenua,
Kia pohiri mai koe ia o whaia
E rau a te Waka ki paoa te rangi;
Te rau o te Huia e noa te tinana tera to piki te Hokioi i runga,
Nga manu hunahuna, kaore i kitea.
E te tini e te mano
Kia takaro koe nga taku tae i waho o Waiwiri(3) i roto o Waikawa;(3)
Ka eke koe ki runga o Pukehou,(4)
Ka whakamau e tama ki waho o Raukawa,(5)
Ko nga moana ra e whakahaná noa ra o Tupuna i te kakau o te hoe,
Ngaro rawa ki Hawaiki.(6)

(1.) Whakaari, now Sandon. Kawana Hunia was born near Reureu, so that the direct road thence to Horowhenua crosses Sandon.
(2.) A high sandhill in Carnarvon, overlooking the delta of the Manawatu.
(3.) Streams between Horowhenua and Otaki.
(4.) A high bluff hill, overlooking Otaki and Cook Strait.
(5.) Cook Strait.
(6.) From which the Maoris say they came to New Zealand.

[TRANSLATION.]

Cease to rest within your house, my son:
Come forth and traverse the plain of Whakaari.(1)
If asked your name, answer,
"Rara o te Rangi" (rib of the sky),
Let not the common man say,
"It is useless against numbers."
It is I who am reduced from high position by appearance of strength.
Think thou of the Fathers, the last of them,
Whakataupotiki, supporter of sky above.
You will issue to the light, to the bright world.
Hasten thy steps to summit of Taikoria.(2)
Glance undismayed and with gestures of challenge over Manawatu.
There stood the Fathers on battle-field, now without men.
Go steadfastly on into Horowhenua,
The shades of your mothers beckoning you forward, the daughters of Waka, undegraded by blows.
Feather of Huia too mean for your person;
Your head-ornament a feather of Hokioi, the bird of mystery, unseen by the multitude.
Wrestle on sands outside of Waiwiri,(3) and up to the Stream of Wäikawa;(3)
Climb steep Pukehou,(4) look forth over Raukawa,(5)
The sea struck by paddles of forefathers, stretching beyond sight to Hawaiki.(6)

ART. LIX.—*Remarks on Dr. H. von Jhering's Paper "On the Ancient Relations between New Zealand and South America."*

By Dr. KARL MUELLER, of Halle, Germany.

Translated from "Das Ausland," Stuttgart, 20th July, 1891, by H. Suter, of Christchurch. Communicated by Professor F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 5th May, 1892.*]

DR. VON JHERING's remarks on the fauna of South America apply to a large extent to the flora also, which agrees with the Australian type in a most striking manner. Mosses are known from Chili which can hardly be distinguished from true Australian species. I was formerly of opinion that the moss flora of Chili and Tierra del Fuego only was related to that of Australia, but I have recently received mosses which prove that this flora extends to Argentina, and even to the Sierra Geral, in south Brazil. This fact evidently coincides with another, long since known—viz., that the Sierra Geral,

(1) to (6). See preceding page.

and especially that portion called the Sierra do Oratorio, has still Araucarias, whose next of kin is at present found only in the Australian region. The readiest explanation of this is that the American and Australian botanical regions are of the same age as Australia itself. A part of south Africa must also be included, especially that part in which the fundamental form of *Proteaceæ* is found.

It should be also mentioned that the Pacific shores of America, not only in Chili (and perhaps Peru), but also in Lower California and as far as north of British Columbia, bear a flora which is mixed with forms which to some extent remind one of Australian types—a heterogeneous combination differing essentially from the vegetable world east of the Rocky Mountains.

But to which geological period must we refer this older flora? I am of opinion that the presence of Araucaria in Brazil should lead us on the right track. When we remember the important part these remarkable plants played in the Carboniferous and later periods, it would seem that they have been here preserved to the present day from, perhaps, the youngest of these periods. Similar observations can be made on some mosses. It is only a short time since I obtained from a bryologist of Rio Grande do Sul a moss from the Sierra Geral which so strikingly corresponded with the true Australian *Dicnemonella* that I felt uncertain whether a mistake had not been made. Soon afterwards my nephew—who is collecting in that place—sent me the same moss from the heights of the Sierra. I was exceedingly astonished at receiving from the Araucaria forests of Brazil a moss type which I should without any hesitation have assigned to Australia if I had been asked to name its native country.

Our phyto-geographers have long since known the relation of Chili and Tierra del Fuego to Australia, but not many conclusions have been drawn about it. No doubt many secrets are still hidden in South America, the investigation of which may very likely open out new ways of considering the faunas and floras of countries, perhaps even their mineralogy and geology. When speaking of the Fuegians, Von Martius says that here one stands before one of the many mysteries which still remain to be solved in the ethnography of South America.

It is my firm conviction that the present flora and fauna of the world contain many forms belonging to very old periods. I am not thinking of the hippopotamus, the giraffe, or the Australian types of animals. No doubt there are living organisms the origin of which reaches back far beyond the Tertiary era—such, for instance, as the singular *Cycadeæ* of Australia, south Africa, Japan, &c. The genus *Lingula*, belonging to the *Brachiopoda*, is one of those which from the

first appearance of animal life in the Cambrian strata have lived on up to the present time. It is represented in each period by several species, and shows throughout the whole line such a striking uniformity in its external characters that distinguishing between the species is often exceedingly difficult.

With regard to the Atlantis, which is mentioned by Dr. Von Jhering, I have dealt with that subject in the "Botanischer Zeitung," and am of opinion, with Wallace, that that point is settled. In Ireland a few mosses occur which are found nowhere else in Europe, but have their nearest allies in the tropics—*Daltonia splachnoides* and *Hookeria læte-virens*. I can only consider them as remnants of a former vegetation which included many more tropical forms, and not due to any great difference in geological time. In connection with this is the occurrence of a phanerogamic grass-like plant—*Eriocaulon septentrionale*—on the Isle of Man, the only representative of the tropical family *Eriocauleæ*.* The fact that these plants have maintained themselves in their home can only be explained by the existence of the warm Gulf Stream, which flows round Great Britain, first striking Ireland. The Gulf Stream must therefore have been in existence ever since these plants had their present habitat; and if this is so there cannot have been an Atlantis, which would have barricaded off the Gulf Stream. Consequently I cannot agree with Unger's theory. By this I do not mean to imply that land bridges never existed. In fact, I fancy I know one myself. But I am of opinion that they are of rare occurrence.

In southern Norway, especially in the Bergen-Stift, there are a good number of plants which are not related to those of the rest of the Norwegian flora, but correspond with the Scottish flora. In the first place there is a moss, *Œdipodium griffithsi*, which is only found in Scotland—where it was first discovered—and in Bergen-Stift: a moss which differs essentially and in many respects from all its allies in the family *Splachnaceæ*, and therefore stands quite isolated. This moss I also consider to be a remnant of an extinct flora. But how came it to Norway? Or how is such a distant occurrence to be explained? Simply in this way: that at a certain geological time there was a land connection, perhaps only imperfect, between Scotland and Norway—a communication which was broken up by the waves of the North Atlantic Ocean, and of which the Shetland and Lofoden Islands may be the remnants. This also easily explains why Heligoland is but a small remnant of a land which, according to Adam v. Bremen, formerly extended over many square miles. More-

* This is not quite correct.—F. W. H.

over, the many Lias fossils which I saw in 1839 and 1840 in a collection at Jever, nearly all of which were changed into pyrites, point to the same fact. . . . There cannot, therefore, be here any question of subsidence, as assumed by Dr. Von Jhering; the bridge between Norway and Scotland was simply broken through and washed away by the waves. . . .

But, to return: As before mentioned, *Dicnemonella kunerti* (mihi), the nearest allies of which occur in great numbers only in New South Wales, is found on the Sierra Geral, in Brazil. A somewhat similar case was recently noticed by me. I was greatly astonished, when naming the collection of mosses of the late Mr. Hildebrant—who unfortunately died while still young in Madagascar—to find a type which very characteristically united the flora of the Cordilleras with that of central Madagascar — viz., the genus *Lindigia*. But my astonishment increased when I found also a second and not less characteristic form in the genus *Streptopogon*. How came these two American endemic moss types to Madagascar? The importance of the matter is much increased by the entomological collections, for the Lepidoptera and the Coleoptera confirmed what I had already found in the mosses. Can a land bridge have existed at one time between Madagascar and the New World; and, if so, how could it have extended from the Andes to Madagascar, as the said mosses live only at medium heights on the Cordilleras? Again, I recently received a collection from a young Swede—Dusèn—from the Cameroon, in tropical west Africa, and found in it a new *Lindigia*, but from low-lying regions. But, as I knew it to exist in Africa, it was only the fact of its occurrence in low-lying regions that was surprising to me. But the fact in itself formed only a fresh point of evidence; for it is well known to the initiated that in the west African tropical zone many plants are met with which have corresponding types in South America. Several mosses are even identical with those of tropical America—viz., *Octoblepharum albidum*, which goes down to subtropical South-Africa; and *Rhizogonium spiniforme*, which is also found on the Comoro Islands. Ascending from the lower regions of the Cameroon to its high plateaux towards Goetterberg, a believer in bridges would be compelled to doubt, for at these considerable heights we meet with corresponding floras of Mexico and Abyssinia ! !, an observation already made by Sir J. Hooker when examining the collections of the German botanist Mann. But this is not all. Everywhere in tropical lowlands where malaria is brewed, no matter in what part of the earth, but especially in the mangrove forests of brackish water, a moss flora occurs the types of which are the same everywhere, and the species are so remarkably alike that

it takes a great deal of trouble to distinguish and characterize them by sharp diagnoses. I have called these mosses "malaria mosses," and know at once the kind of climate of their home, wherever they may have come from. What is the significance of this? Nothing else but that the same climatic regions have produced the same types—either the same or, at any rate, very similar species. There can be no question of migration, because the malaria mosses occur far in the interior of a continent as well as on its coasts, provided the low-lying land is tropical. This was strikingly shown by the mosses collected by Dr. George Schweinfurth in the lowlands of central Africa, especially in the districts of Niam-Niam, Monbuttu, &c., and which were intrusted to me for determination.

I come now to a still more remarkable circumstance—viz., that the floras of certain districts are not homogeneous, but exhibit amongst their warp a woof which has nothing in common with it, but exhibits the stamp of a totally different flora. I have already mentioned it in the Australian type, which beyond a doubt belongs to the oldest forms of plant-organization on our globe. It is well known to phyto-geographers that this Australian type extends in Chili down to Tierra del Fuego and its islands, and eastwards as far as Brazil. In this large territory, including the Island of Chiloë, mosses are met with which resemble with wonderful closeness species from New Zealand. But the same thing is seen in Africa also, especially south Africa, which in its *Proteaceæ* really repeats Australia. West Australia, which has in every respect a totally different flora from eastern Australia and its islands, shows forms which are peculiar to Africa, and which must be very surprising to West Australian phyto-geographers —viz., the monkey bread-fruit tree, or baobab. Over the whole enormous extent of Africa there is only one species (*Adansonia digitata*); Australia has furnished a second in *A. gregorii*, but this is found in such an isolated region of the interior that the question, From which of these points did the type originate? has lost its sense. Australia did not receive it from Africa, nor did Africa receive it from Australia—it is autochthonous in both places; and one sees here once again that the same conditions of creation produced in different places the same type, only in different species. If this be not the case, the enigma cannot be explained by migration, for that necessarily includes the idea that the reproduction of the type was successful in one place only. This always makes on me the same impression as the idea of explaining the origin of organisms by deriving them from some other globe. What is gained by it? Nothing else but that the cause of origin is put further back; for, after all, one is obliged to ask, Where [illegible] the organisms of that strange globe come from?—they

must have originated somewhere. With such explanations, one wanders without knowing it in a circle, if one does not wish to arrive at the absurd conclusion that the creation of organisms was possible on one globe only. It is the same with migrations. I do not deny them when they are opportune, and I know very well that wind and weather, animals and men, are able to distribute species sometimes over large areas; but it is quite a different thing when we have to deal with the spreading of whole floras, sufficient to impress one district with the stamp of another, where all the species are united in an organic association, so that one cannot be understood without the other. This cannot ever have been accomplished by a migration of a mechanical nature.

Sufficient attention has not hitherto been paid to isolated types standing apart in floras. Examples are numerous, but I will mention only one of the genus of mosses—*Drummondia*. Its history is much the same as that of *Adansonia*. Originally it was discovered in North America as *D. clavatella;* afterwards I pointed out a second species—*D. obtusifolia*—in Chili; and finally the English traveller T. Thomson discovered a third species—*D. thomsonii*—in Thibet, on the heights of the Himalaya. How comes such a characteristic ground-form of the United States upon the Cordillera of Chili and upon the icy heights of central Asia? The answer is, Because the conditions of creation at all these three places on the earth produced it as the sequence of given circumstances. Any other answer is unscientific. Chemico-physical agencies produced it. Under this head it is possible to think of something, but any other explanation is unthinkable. But one can turn the spear if one fixes the eyes upon Australia. There, of course, the Australian types dominate in such large numbers that they give to the flora the characters of a former age. To the earlier German botanists, such as Dr. Behr, of Anhalt, it appeared remarkable that there are districts on the Australian Continent where, to the surprise of the observer, European forms were found at a time when no considerable immigration had taken place. But even if the immigration had been large it would not have mattered much, for, although the genera were European, the species were spontaneous. Whence did they come to Australia? Answer, From no other place than Australia itself, for they are not known in Europe. Even Africa has a claim to similarity like Europe. In South Australia a fern occurs with a considerable development of the stem—a species of the genus *Todea*. Only one species was known from South Africa (*T. africana*), which so closely resembles the Australian species that for some time they were thought to be identical; but their specific difference

is now known. This is a parallel case with the famous *Adansonia.*

But now comes the best proof. If we look backward for many hundreds of thousands of years, we see an Australian flora growing on the soil of Germany. Unger explained the origin of this flora by imagining the Atlantis as a land bridge for the migration of plants from Australia to Germany. After what has been said above, it is not worth while to criticize this idea. But I myself, from the fact of the former existence of an Australian flora in Europe, draw the conclusion, justified by what has been already said, that this flora was also autochthonous. This conclusion includes another—viz., that all flora-districts of Australian stamp must have been of the same geological age. A single glance at palæontology shows that each geological period had its own characteristic fauna and flora. What the causes were is still a question, but the fact is established. In many districts outside Australia these types have been preserved separately, and therefore we have to draw a third conclusion—viz., that our present flora-districts are the result of many preceding geological periods, here more, there less. This is very strikingly confirmed by the fact that the well-known tulip-tree (*Liriodendron*), with which we first got acquainted as *L. tulipifera*, from North America, was afterwards discovered in the district of the Yang-tse-kiang River, in China, in the form of *L. procaccinii*, a species already present in the Miocene of Europe. Consequently all explanations of origin by migrations and bridges cease, and we are forced back on the idea of autochthonous causes. And this is only a single example among many other occurrences which altogether negative what has been hitherto said about the transmutation of species.

Although not an unconditional believer in all the bridges adopted by Dr. Von Jhering, yet I am glad that he admits that there are Australian forms in South America, and connects them with those which we find at present in New Zealand and elsewhere in Australia, and that I meet with the opinion that the present continents have originated from former islands, which were united by successive elevations in different geological periods. I am also very pleased to see that Dr. Von Jhering is of exactly the same opinion as myself, that Darwinism will belong only to history after a few decennaries, so far as it tries to explain the origin of species.

Art. LX.—*The Effect of Deer on the New Zealand Bush: A Plea for the Protection of our Forest Reserves.*

By the Rev. P. Walsh.

[*Read before the Auckland Institute, 22nd August, 1892.*]

With the exception of that of the domestic animals, most of the attempts at acclimatisation that have been made in this country have been unfortunate. The small birds are a severe tax on the farmer: the rabbits threaten to break up the estates of the large landholders, who are said to have celebrated their introduction with a champagne lunch: while the stoats and weasels, from which so much was expected, have not only failed to accomplish the object desired, but are already, in the destruction of native birds, and in their depredations in the fowl-yard, proving themselves an intolerable nuisance.

Still, though the mistake is now generally admitted, the attempt in these cases was somewhat justified by the hope, delusive though it soon proved to be, of some tangible benefit that would more than compensate for any attendant evil. This justification, however, can hardly be allowed in the case of deer, unless their introduction be accompanied by certain restrictions that have not hitherto been observed. For, although there may be few forms of enjoyment to equal that which would be found in stalking the grand game amongst our forest-clad mountains, still those in a position to enjoy the sport would necessarily form but a fraction of our population, while even the keenest sportsman would hardly be content to purchase his own gratification by the destruction of that forest which is the glory of his country and the birthright of the community at large.

To those who are unacquainted with the New Zealand bush it may seem strange to associate the idea of destruction with a few head of these innocent-looking creatures. They are perhaps familiar with the idea of an Old Country deer-park, where the animals wander harmlessly among the sylvan glades with no other effect than that of giving life and beauty to the landscape; and they would be surprised to learn that the presence of the deer would prove more injurious to a rata or a kauri than to an elm or an oak. And, indeed, if they made the comparison at all, their conclusion would probably be in favour of the giant growth and the massive density of our own forest. The two conditions, however, are entirely different, and the comparison is not so easily disposed of. The European forest or deer-park, it must be recollected, has

grown up *subject to the presence of ruminants of various kinds* —that is to say, the several species of trees and shrubs composing it have overcome (perhaps with artificial assistance) any struggle they may have had when young and weak, and the whole is now able to take care of itself. Again, the understuff in a great part consists of seedlings from the older trees, of which, though many may have been cropped or broken, a sufficient number have survived to replace the older growth. And, besides this, the floor of the forest is generally covered with a quantity of grasses, fern, and brambles, which spring up every year, and which amply supply the wants of the animals.

But in the New Zealand bush the case is quite opposite to all this. The forest has grown up through the course of ages undisturbed by any four-footed enemy whatever. In its virgin state there is no grass, properly speaking, at all, while the undergrowth of ferns, shrubs, and seedling plants, once destroyed, can never be restored. And, moreover, the constituent portions are so dependent on each other for nourishment and protection that, once the balance has been disturbed, the entire growth rapidly suffers.

It may seem incredible that the towering kauri or the giant rata, whose twisted limbs, loaded with a fairy garden of epiphytes and climbing-plants, have weathered a thousand storms, should be in any way affected by the removal of a few insignificant plants from about their base. But so it is. They, and all, or nearly all, of the larger trees in our bush, are dependent for their very life upon the growth which is so thoughtlessly allowed to be destroyed. As may be easily seen after a bush-burn, or where a tree has been overturned by the wind, the principal roots scarcely penetrate the ground. Running like a network of tangled snakes along the surface, they are protected by a sort of humus composed of decaying vegetable matter, which is kept in a moist condition by the multitude of ferns, mosses, and small plants of every kind which occupy every inch of space wherever the forest is undisturbed. Once this growth has been destroyed, which very soon happens when a browsing animal is admitted, a change begins to pass over the scene. The larger trees, deprived of the shelter at their feet, gradually grow thin and open at the top. The cathedral gloom and the damp solitude in which flourished the palm-like nikau and the stately fern-tree are penetrated by the burning sun, and invaded by fierce and parching winds. All the magic profusion of grace and beauty begins to shrivel and die; and as further desiccation takes place the unprotected roots can no longer support the strain they have to bear, and every here and there some hoary patriarch falls crashing amid an acre of ruin. And thus the game goes on: each step in

the chain of destruction preparing the way for the next at an accelerated rate of progression until the ruin is complete, when sooner or later the desolated region is swept by the fire from some neighbouring clearing, and at last a few charred stumps and bleaching skeletons are all that is left to mark the irretrievable loss of a paradise of beauty.

That this destruction is constantly going on may be seen in all the older settlements, where it may be observed in the rapidly-shrinking area of the standing forest and in the prevailing grey and brown tones of the tree-tops, which, with the dry and lifeless branches, impart an air of gloomy monotony to the portions which still remain. In some districts whole families of trees are fast disappearing. Of the tawa, a tree of very wide distribution and one whose value is just beginning to be recognised, it is now in many places a rare thing to find a perfect specimen.* The thin bark on its slender superficial roots bleeds to death on the slightest injury, and the tree rapidly perishes. The mahoe and the ngaio, once found in abundance on the Auckland isthmus, are now almost a thing of the past; and the whau, a handsome broad-leaved shrub which flourished in rich volcanic situations, is, in most settled districts, practically extinct.† Other trees make a longer struggle for life; but, sooner or later, with few exceptions and under more than usually favourable circumstances, they all succumb to their change of condition.

All this lamentable ruin has been brought about in a very few years mainly by the cattle of the settler, many of which have gone wild and roam in constantly-increasing numbers among the forest-clad ranges; and, as has already been ascertained, wherever the deer have found a home their ravages upon the vegetation are even more rapid and fatal than those of the cattle. Nor is this surprising when we recollect that the instinct of these animals causes them to seek the protection afforded by the seclusion of the bush, and the fact that they are less dependent than the bovine species upon the grasses and other products of the open country, while actual observation of their haunts shows that not only are the twigs and foliage cropped to a most injurious extent, but that even trees of considerable size are frequently denuded of their bark.

It must, of course, be admitted that there are many species of trees which even a deer will not touch, and that the larger specimens are beyond the reach of their attack. But, although this is the case, still every one at all acquainted with the subject knows how difficult it is, even under the most favour-

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* See Kirk's "Forest Flora of New Zealand," article "Tawa."

† *L.c.*, article "Whau."

able circumstances, to save a tree which has formed part of the standing bush, once the surrounding shelter is destroyed; and, though here and there an individual of a few of the more robust species—as, *e.g.*, the puriri and the karaka, or the totara and the rimu—may with great care be preserved to form a graceful object in the landscape, still, with the removal of the beautiful undergrowth, the whole character of the bush is gone; and, instead of the "forest primæval," there remains but a poor imitation of a second-class English park.

It is not to be supposed that our bush can for ever be wrapped up in cotton-wool, so to speak. However we may lament, by far the greatest portion of it is destined to fall under the axe of the timber-man and the settler, though even the settler would find it greatly to his advantage in point of utility as well as of beauty were he less ruthlessly destructive than he generally is. Still, an attempt might be made to do something to preserve at least a few limited areas of the forest in its virgin state. The Mount Egmont reserve, in the Province of Taranaki, is a case in point. A generous policy has set apart the whole of the wooded slopes of the mountain within a radius of six miles from the summit as a State reserve, and it is hoped that the boundary may be extended to include the adjacent ranges. Similar reservations might easily be made in many of the mountainous districts of both Islands—as, *e.g.*, portions of the Coromandel Peninsula, the Great and Little Barriers, Te Aroha, Waitakerei, the Nelson sounds, the Southern Alps, and many other places where the land, though unfit for economic settlement, is, from a scenic point of view, unsurpassed in any part of the world. But it is not sufficient merely to mark off so many blocks of land on the survey charts. They must be protected, and that without delay, by something more substantial than an announcement in the Government *Gazette*.

The system of protection that obviously suggests itself would be at once simple and effective, and, considering the interests at stake, comparatively inexpensive. A broad track along the boundary-line, cleared from all dead timber, and flanked by a substantial fence of barbed wire, would serve all the purposes required, especially if a ranger were appointed, with full powers to shoot down all trespassing animals, and to prosecute any person found lighting fires or otherwise injuring the vegetation. It is to be hoped that this will be done, or it will be found when it is too late for remedy that the brightest flower has been plucked, and the glory has departed from the Garden of the South.

Postscript.—It will be observed that I have dealt with the question from the æsthetic rather than from the economic

point of view. I have done so as my remarks are intended to apply chiefly to the portion of the forest which may be reserved for State parks, in which, by a little timely precaution, some of the natural beauties of the country may be preserved, to contribute to the health and pleasure of future generations of our people as well as of the increasing number of visitors from other lands, my attention having been specially drawn to the subject by the announcement that deer have been recently enlarged on the Taranaki reserve.

As regards the timber-bushes and the forest of the North Island generally, the case, I fear, is hopeless. What with the continued extension of farm-clearings, and the fires which originate among the *débris* along the road- and telegraph-lines and in the old kauri-workings, the greatest portion of the bush is going to rapid destruction. Every summer the country is enveloped in smoke and flame, and the fires rage through the standing bush, long since denuded of its natural protection.* Every season witnesses the blighting of many a lovely spot, and the waste of countless quantities of valuable material;† and, though here and there a settler of unusual artistic spirit may manage to save a little patch from the destruction around him, any general attempt would be at once laborious and futile.

ART. LXI.—*Unwritten Literature.*

By R. COUPLAND HARDING.

[*Read before the Wellington Philosophical Society, 26th October, 1892.*]

Is the expression "unwritten literature" a paradox? Only, I submit, when the literal structure of the word "literature" is allowed to veil its true meaning. The dictionary definitions, even, exclude the greater portion of what is written and printed from the category of literature. Just as music is independent of any system of notation, and existed long before such was devised, so is literature proper a thing apart from the altogether arbitrary and conventional means by

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* In 1890, the fires which had started in the neighbourhood of Normanby travelled along the old clearings as far as New Plymouth, a distance of forty miles, destroying grass, fencing, &c., besides killing quantities of standing bush.

† In 1888, the Puhipuhi Forest, between the Bay of Islands and Whangarei—the most extensive kauri-bush existing—was on fire for several weeks, when about *one-third* of the area was traversed by the flames. It is estimated that the trees killed on that occasion contained at least three hundred million feet of timber.

which it is perpetuated. The song, the proverb, the fable, or the history inscribed in set form of words upon the tablet of the human memory is as truly literature as if with an iron pen and lead it were graven in the rock for ever.

At a recent meeting of this Society some disparaging remarks were made on the subject of Polynesian poems and traditions. They were described as barbarous, the productions of savages, untrustworthy historically, and scientifically worthless. It is quite in the spirit of the nineteenth century to despise people who have not, like us, inherited the traditions of a remote civilisation. With some considerable knowledge of metals, it is easy to disparage those races who have had no more efficient tools than they could construct from stone or shell. But I am inclined to question whether this assumption of superiority is an evidence of the scientific spirit. The seeker after truth, no matter in what sphere, should hesitate before he assumes any fact to be worthless. The rejected materials of to-day may be the prized treasure of to-morrow; and, however little they may seem to bear upon the special pursuit of the inquirer, the various branches of science are so closely correlated that if one suffers the others must share the loss.

To the anthropologist, the language, the folk-lore, proverbs, and traditions of any people, however rude and primitive, are far from worthless; and their careful study has thrown, and must yet throw, more light upon the most fascinating of all studies, and one of the most important—the past history of mankind. Archæology has shown that many ancient traditions, long rejected as myths or fictions, are actual historic facts; and the oldest historians, once ridiculed for their credulity or branded as liars, are now treated with growing respect, as discoveries of buried cities and ancient inscriptions confirm their histories to the letter. It is no doubt the tendency of all traditional history to shade by imperceptible degrees into the mythical or the allegorical; and the Polynesian genealogies, reaching back to deities of the heavens and earth, or even to fabled saurians and sea-monsters, are paralleled by the classic traditions of civilised Greece and Rome.

It is not, however, to the historic value or otherwise of these traditions that I would specially refer. I would merely note that they must have descended from remote times with very little change, as they are in many cases the common property of races far apart, and have survived many changes of language and external conditions. The purpose of this paper is to inquire how far, if at all, these primitive peoples—the Polynesians specially—possessed what may be called literature.

It is first necessary to endeavour to place ourselves mentally in the position of the people whose inheritance of tradition

we are considering. This is not easy. We are, as a people, so vain of our material and external advantages, of our supposed moral, religious, scientific, and intellectual superiority, that we are apt to regard "savages" as on a different plane, and almost to overlook the fact of their common humanity. It must be as difficult for the primitive man to realise our superiority. It is quite possible that, regarding modern society critically, he would find what he might deem savagery in the relations, say, between labour and capital; he might even detect a want of decorum in the proceedings of our legislative and deliberative assemblies that would shock his sense of etiquette; while his finer feelings might be outraged by our contempt for objects and usages which in his eyes are extremely sacred. Though he learn to speak and read our language with some facility, we can scarcely expect him to appreciate the beauties of "Paradise Lost." And, though we may have some superficial acquaintance with his native tongue, we may be equally unfit to criticize, and be equally blind to the force and beauty of, the traditional lore, poetical and didactic, which embodies the wisdom and the religion of his race.

In fact, to institute a fair comparison, it is necessary to exclude all such literary and other growths on our side as are due to difference of environment. If we do this, our claims as a people to intellectual superiority must be greatly reduced, and in some respects we may even find ourselves at a disadvantage. The man who is always surrounded with books has not the same incentive to cultivate his memory, or to master details, as he who has no such external resource. Few writers can quote correctly, even from their favourite authors, without reference. The "bad memory" of the civilised man is, like colour-blindness or myopia, a defect largely due to his artificial habits, and from which the unlettered islander is exempt. A man with such a verbal memory as was possessed by Scott or Macaulay is to us a marvel: in the case of the bookless Polynesian he is not the exception, but the rule.

There have been rare cases in which a man has been able to repeat the entire text of the Scriptures. In the most celebrated case of the kind the development of this faculty of memory was at the expense of the other mental qualities. But a capacity of memory equal to this must have been quite a common thing among the Polynesians. The parallel holds good not only as to the quantity of lore stored in the memory, but to a great extent as to its form and quality. Within the compass of the Scriptures we find every kind of literature—traditional, historical, genealogical, philosophical, proverbial, moral, and devotional. The large section of our modern books which are unrepresented there—such as treatises on the exact sciences, natural philosophy, and theoretic science—do not

properly come into the category of literature. That these ancient writings are of a high literary standard is universally admitted. It is acknowledged, for example, that no metrical translation of the Book of Psalms does justice to the original. In the earlier portion of Genesis we have a document of unknown antiquity, which many critics hold was preserved in the form of tradition before it was committed to writing. The same view is held with regard to the ancient epics attributed to Homer. In each instance we have work of a very high literary quality—in fact, many would say, of the highest. In their particular sphere they are unequalled. The Duke of Buckingham's eulogy is well known:—

> Read Homer once, and you will read no more,
> For all books else appear so mean, so poor;
> Verse will seem prose: but still persist to read,
> And Homer will be all the books you need.

Whether Mr. Gladstone would agree with such unqualified praise, I cannot say; but, omnivorous reader though he be, he is said to read Homer daily, with an assiduity greater than many devout folk give to their Bible. Yet I must say that the offhand criticism which would reject Polynesian poetry as worthless must, to be consistent, pass a similar verdict on the "Iliad" and the "Odyssey." As giving an insight into primitive society, one is as valuable as the other; and, apart from the difference that in one case we have a knowledge of metals, we find a remarkable parallel. In the light of the civilisation of to-day, one people appears as savage as the other. There is the same interweaving of the natural and supernatural, of history and myth; the same exhibition of the fiercer aspects of human nature; and the resemblance is not only general, but can be followed in details. The egotistical vaunting and taunts with which Homer's chiefs go into battle have their exact parallel in Maori legend and history.

There are good reasons against quoting from poems and proverbs already on record in the Transactions; and to adopt such a course would unduly expand this paper. There is the less need, as in two separate papers read at last meeting several highly poetical fragments were brought forward by gentlemen well qualified to deal with the subject.

I have already referred to the remarkable powers of memory displayed by the chiefs and priests who were the depositories of the national lore; and this is evidenced by the literal accuracy with which genealogies, incantations, songs, or proverbs were handed down from generation to generation. This is proved by the retention of archaic words and forms of expression; by the fact of the same narratives being the property of peoples remote and long separated, and having survived great changes in language and conditions.

One cause of this scrupulous accuracy was, that the omission or change of a single word in a powerful charm was sufficient to destroy its efficacy, and lead to dire disaster. This regard for verbal accuracy is commonly supposed to be characteristic of a somewhat advanced stage in literature. Loose quotation seems to be a feature in all old writings, and is common enough still with hasty and slovenly writers.

It is easy to disparage the quality of native lore on the ground that it is elliptical, obscure, and at times when literally translated wholly unintelligible. The difficulty which meets the translator or collector on the very threshold of his work is the allusiveness characteristic of all the songs and sayings. The most brief and pointed proverb may embody some reference to an old hero, a national custom, the habit of some obscure plant or animal, or to some well-known fable or story. Before it can be understood, a great mass of native lore must be mastered, and if literally rendered it is meaningless without annotation.

This quality may be readily illustrated by a little consideration of our own proverbial expressions, which in numberless cases owe all their force to their allusion to some familiar story, native or exotic. Nearly every one of Æsop's fables has crystallized into a proverbial phrase, as for example: "to cry 'Wolf!'" "to nourish a viper in one's bosom," "to bite at a file," "to grasp at a shadow," "sour grapes," &c. Leaving out the Scripture references and phrases with which common conversation and literature abound, we could collect innumerable every-day phrases from the "Arabian Nights," from the works of the masters of fiction, and from nearly every work which has made an abiding mark on our literature. Shakspeare is quoted unconsciously in the most ordinary conversation. And not to old writers alone does this rule apply. The pointed sayings of living men have passed into the literary currency, and the great poet whose loss we all mourn has left us no small store of "jewels five words long, that on the stretched forefinger of all time sparkle for ever." As the same rule is of universal application, foreign proverbs and phrases, conveying no idea to us, may be full of meaning to those by whom they are in daily use. I have already referred to Milton's "Paradise Lost." No one can appreciate or even understand the greater part of that work without some acquaintance with classic fable, Scripture history, rabbinical tradition, and the vocabulary of architecture and other arts. A work of a much simpler and more popular kind, the "Pilgrim's Progress," is so saturated with Scripture phrases and references that a very thorough acquaintance with the Bible is necessary to follow its allusions. To those who can appreciate the references, they add a great charm to

the work. What therefore is considered to be a beauty in our own literature can scarcely be a blemish in the lore or literature of other peoples whose habits of life and thought differ from our own.

I have referred to the Scriptures as embodying every form of literature in the true sense of the term. This being admitted, there is very little which may not be paralleled in Polynesian lore. There is the most ancient portion, containing a cosmogony and genealogies, no longer accepted as literal history. To the rationalist it is pure myth; to the theologian it is a Divine allegory, for which each school of thought has a different interpretation. Parallel with this, we have the native cosmogony, beginning, as all others do, with Night and Chaos. For aught we know, allegorical meanings may lie concealed in these traditions, which have been handed down for so many ages—at all events they are highly poetical in form. It may be that the outward shell, still preserved and venerated, has outlived the forgotten esoteric meaning it conveyed to generations long past. From the mythical we come to the firmer ground of the tribal and national chronicles; then we have the prophets and the psalms. These are to a certain extent paralleled by the poetical lore of the natives. Some of this was prophetical; some devotional; much of it consisted of charms and incantations; and, again, we have the deeds of heroes, fables and apologues; love-songs, not only of the erotic order, but often expressing pure and tender affection, in refined and graceful language. This poetry constituted what, if committed to writing, would certainly have every claim to be called a national literature; that it was highly prized is evident from the enormous pains taken to commit it accurately to memory. In the Rev. W. Colenso's paper on the Ideality of the New-Zealanders, in which he gives typical examples of Maori poetry (Trans., vol. xiii.), he states that Sir George Grey had collected between five hundred and six hundred songs, and that to these he could add an equal number collected by himself. This does not by any means exhaust the whole.

From poetry we pass on to proverbs. This is a subject which has received a good deal of attention from contributors to the Transactions. The Rev. W. Colenso (vol. xiv.) has written largely on Maori proverbs, and has quoted freely from a store of twelve or fourteen hundred which he has systematically classified. It is not too much to say that in practical worldly wisdom, in their recommendation of virtues and condemnation of vices, and in sententious force, they will bear comparison with any other collection, sacred or secular.

In drawing these parallels, I am not claiming for the native lore the high spiritual character of the Hebrew canoni-

cal scriptures, though it may fairly take rank with many of the puerile apocryphal writings and rabbinical commentaries. The Hebrew prophecies and psalms, where the Eternal is supposed to speak, rise to a sublimity unparalleled elsewhere. Without this lofty ideal, it was not possible for the religious utterances of the Maoris to approach them in dignity. Nor, in the absence of written records, could we reasonably expect to find sustained argument or systematic connection, such as mark the principal Scripture books. Such a production as the Book of Job, for example, with its symmetrical form, its dramatic power, and its philosophical treatment of the deepest problems of life and providence, is wholly unlike anything in the literature of an uncivilised people. But this particular book—of vast and unknown antiquity—is unique. It stands absolutely alone in literature.

If, then, the substance of the native poetry and proverbs is to be commended, the question remains as to their form—whether it is rude and barbarous, or sufficiently finished and symmetrical to bear critical examination from a literary standpoint. To this there can be but one answer. The language itself is flexible, expressive, and exact; and the songs and proverbs were arranged, like the Hebrew poetry, usually in a dual form, the two lines being either parallel or antithetical in sentiment. Rhyme was not known, but regular measure and cadence were observed, and each song had its proper *rangi* or melody. In the absence of letters, such an artificial refinement as the acrostical form of the later Hebrew poetry was impossible; but, as Mr. Colenso has shown, even this was in a measure paralleled by the device of beginning many consecutive lines with the same word or short phrase—a very characteristic feature of Maori poetry. Attentive readers of his paper will have noticed one point which some of the pieces quoted possess in common not only with Hebrew poetry, but with the ballads of northern Europe—a perpetually-recurring burden. In the very curious "soothing charm" used to allay the pain of tattooing, the burden, recurring some nine or ten times, is "*Pirori e!*" and Mr. Colenso says that he finds great difficulty in finding a satisfactory rendering of so brief and elliptical an expression. I imagine that an equal difficulty would be found in interpreting the "burdens" of many old English, Scottish, or Danish ballads. Most of them, at all events as regards the narrative they interrupt, are as meaningless as the chorus of a music-hall song. But they are often remarkably quaint and curious, and it is worthy of note that they are so closely paralleled in Maori poetry. Before leaving this subject, I cannot refrain from an allusion to a wonderful and beautiful native poem, one of the most ancient and curious in existence—the song or charm of Paikea.

It abounds with obsolete words and archaic forms, and is most difficult to translate, but is a marvel of poetic genius. In force and vigour, in imaginative power, in beauty of diction, it is unequalled in its own particular line.

The natives fully recognised that a poem of this class was a piece of work of no common order; and they had their own theory about the Divine afflatus. According to the authority I have already quoted, "the old Maoris even professed to have heard songs, of a highly curious character, sung by the spirits of the dead, and by fancied *atuas*, supernatural beings, while engaged in fishing far out at sea." Like the ancient Greeks, they firmly believed in Naiads, Dryads, and Nereids, and made them conciliatory offerings. Rather than grieve the gentle wood-nymphs, the old Maoris would trudge long distances in quest of dead timber and drift-wood, so as not to break or destroy the graceful shrubs by river-side or estuary-shore. What a contrast when the civilised European made his appearance! In this belief in sylvan divinities we have one of those touches of nature which make the whole world kin. Milton and Shelley to the contrary, Christianity has not expelled the guardian spirits of the woods and streams—it seems merely to have changed their titles. Ever and anon, in some French or German village, the Naiad still appears to some wandering maiden, the healing fountain breaks forth where her foot has trod, and another sect is added to the thousand-and-one already in existence. It is true that the vision appears in the form of some venerated picture, and is given a New Testament name; but she is one of the nymphs that the Hellenes revered of old, and that the Maoris knew so well in the woodlands before the destructive pakeha came and ravaged them with fire and steel. Science has tried even harder than religion to exorcise the guardian spirits of land and sea; but it cannot expel them from literature. Who can say that it may not yet have to recognise them in Nature?

Is it possible for the man who has his own library, and access to still larger collections of books, to mentally place himself in the position of the intelligent Maori, with only the book of Nature and the other book of ancestral tradition inscribed upon his memory? The Maori was schooled to verbal accuracy, and had little, if any, external mnemonic aid. In his power of correctly reciting song, proverb, and genealogy he is, compared with the reference-hunting pakeha, a strong-limbed man beside one on crutches.

It remains now to inquire how far this "savage" literature affected life and character. The natives possessed alert intellect and vivid imagination, with the power of swift and accurate observation; and this traditional lore, we have to remember, was to them all that is represented in our case by Bible,

library, and newspaper. It was the sole storehouse of mental food possessed by an intelligent race. In their songs relating to departed and sometimes deified ancestors, in their prayers and charms, they felt the presence of the unseen, and must have realised, if only in a vague degree, some of those truths underlying all religions, and which holders of more advanced and systematic creeds claim to have been made known by direct revelation. They had a very real and abiding sense of the existence of a world of spirits. If we are inclined to scoff at their belief in witchcraft, we have but to look back three hundred years to find the whole of Christendom on the same mental level. If we find fault with their necromancy, we may see exactly the same thing revived to-day in the "spirit circles" in our own communities. The lore of the Maori was exactly appropriate to his mode of life and his surroundings. It afforded him just the mental exercise that he required. His songs cheered many an hour of privation and weary toil; his potent charms inspired him with hope and courage; his wise and pithy proverbs urged him to diligence; and thus his mental and moral faculties were strengthened.

Poetry, some would persuade us, is the outcome of an imperfect development; and certainly, with the advance of material science the higher forms of literature seem to be less appreciated. This applies to art of every kind. We may yet find that there is something to admire in the uncivilised man, and even something to be learned from him. As a typical example of the ghastly side of human progress and science, we have only to look at the desecrated Manawatu Gorge, where Nature is taking effective revenge for the outrages inflicted upon her. Primitive man lived nearer to Nature than we do to-day, and understood her better than we. Primitive man has left us from remote ages a legacy of literature that we cannot now surpass.

There are some who hold that poetry, the loftiest of the arts, is doomed to perish with the progress of material advancement. The illustrious Darwin was, by his own account, an example of the "atrophy" of the æsthetic faculties induced by too exclusive a devotion to physical science, and appears to have been to some extent afflicted with atrophy of the faculty of spiritual insight as well. But, whatever the general tendency of the age may be, modern progress has not succeeded in quenching the poet's inspiration. The two great men on opposite sides of the Atlantic who have just departed have proved that the highest poetic gifts may co-exist with a very sordid and materialistic condition of society; that the art of printing, though it has been the means of overwhelming literature with a deluge of rubbish, has not quite killed it; and that, though primitive man is not without his poets and

prophets, it is not for us to forget or disparage our own, the highest of whom may fairly rank above statesmen or men of science, and who are—it is not too much to say—a century in advance of the great body of their fellow-men.

Art. LXII.—*Observations on Rainbows.*

By R. Coupland Harding.

[*Read before the Wellington Philosophical Society, 7th December, 1892.*]

So many conditions are necessary for the appearance of a perfect rainbow that the sight of one is really very rare. The sun must be shining clearly in one quarter of the heavens, and in the opposite quarter there must be an unbroken rain-cloud screen of sufficient extent for the projection of the bow. In nearly all cases one or both bows are only fragmentary. I have not the knowledge of optics necessary to deal with the subject in a scientific manner, and only wish to note some unusual phenomena in connection with rainbows, of a kind not provided for in popular text-books. I should like to know if others have observed similar appearances. That they may, if they watch for them, I do not doubt. Usually one sees no more than one looks for or expects to see, unless for some reason special attention is given to the object observed.

The ordinary primary and secondary rainbow of the text-books are familiar to us all. But the first point I would note is that the closest observation often fails to detect any sign of the secondary rainbow, even when all the conditions are apparently favourable for its appearance.

About three years ago, in Napier, looking at an unusually brilliant rainbow, I was struck with the great breadth of the band of colour. Looking more closely, I saw that the spectrum was double. This was also the case with the portion of the secondary rainbow which was visible at the time; but in this case the additional bands were so faint that I should not have seen them had I not been led to look for them through having noticed them in the primary bow.

Shortly afterwards, looking at another bow, I was unable to discern the second series of colours either in the primary or secondary; but, to my surprise, I distinctly saw a tertiary bow, the colours, as might have been expected, following the order of the primary.

Both of these phenomena—the double series of colours in one bow, and the tertiary bow—I noticed on other occasions

in Napier during the same rainy season, but on no occasion did I see both at the same time.

In Wellington, last June, seeing a fine bow, I looked to see if it presented any peculiar feature. It was only on close examination that I detected that this one was double ; and, to my surprise, I saw what I had not noticed before, that in the second spectrum, forming the inner portion of the bow, the colours followed the same order as the outer and brighter series. I failed to see any colourless space between to represent the invisible portions of the spectra, and thence inferred that they must have to some extent overlapped.

I do not attempt to account for these variations in the appearance of the bow, but should now scarcely be surprised, under more than usually favourable conditions for observation, to see at the same time three double rainbows in the heavens.

POSTSCRIPT.—Mr. T. B. Harding, to whom a copy of the above note was sent, writes,—

"On reading your paper, I could not account for the doubling of the spectrum ; but I have since met with a scientific note which I think may afford an explanation of the cause. It appears that often the larger drops of rain are not solid, but hollow spheres, as they are found to mark what they fall on in rings [○], while the others make spots [●]. Now, it seems evident that, as a glass globe empty, or, rather, filled with air, will refract differently from one filled with water, so the two classes of raindrops will give differing spectra (in position), yet, as we may imagine, so close together as to appear continuous.

"With regard to the third rainbow, I do not see how it could be formed in the ordinary way, as it would need three reflections within the sphere, and two refractions, one on entering and one on leaving. But there is another way in which they may be formed—as a diffraction spectrum. I saw one of them on Friday afternoon, the 11th November. The sky where it was was *clear*. The arch was about 60°, and resting at the ends each on a cloud. Turning towards the sun, it appeared covered with a granulous cloud which acted as a kind of grating or diffracting medium, and the effect was perfect. It was not raining where I was, and did not appear to be where the bow was seen.

"I do not expect that you will ever see *three* double rainbows at the same time."

Art. LXIII.—*On Rainbows caused by Reflection in Still Water, and on Elliptically-generated Rainbows.*

By Major-General Schaw, C.B., R.E.

[*Read before the Wellington Philosophical Society, 18th January, 1893.*]

Plates L. and LI.

There are two ways in which, under special conditions, the phenomenon of the rainbow may be produced by reflection from the surface of still water:—

1. By the reflection of the sun itself, which forms a virtual image of the sun at the same angle of depression below the horizontal as the angle of elevation of the sun above it. The rays from this reflected image of the sun act on the raindrops in the same way as the direct rays from the sun, and produce an image in the observer's eye of another rainbow at a higher altitude than the rainbow produced by the direct rays of the sun. Such rainbows have been observed not unfrequently.

2. Although I have not been able to trace any record of its having been actually observed, yet undoubtedly under suitable conditions the reflection of a rainbow might be seen on a reflecting surface of still water—not the reflection of the rainbow seen by direct vision, but that of another rainbow which would be visible on the rain-cloud to another eye in another position.

Before entering on any explanation of these special cases it will be desirable to rehearse succinctly the causes and modes of production of the ordinary rainbow.

The essential conditions under which the rainbow-image can be formed in our eyes are the following:—

1. The sun shining clearly behind the back of the observer, and low down—*i.e.*, at an altitude of less than 40°. The nearer the sun is to rising or setting the larger the visible bright arc of prismatic colours.

2. A sheet of falling raindrops in front of the observer, with rain, cloud, or other dark background behind it.

3. Moonlight under the above conditions will also produce a rainbow, but owing to the feebleness of the light the colours are rarely distinguishable, and it appears as a white rainbow. White rainbows also may be produced by sunlight if the raindrops be very fine, or if the sun be partly obscured by thin clouds: in either case so many spectra are produced that they overlap and neutralise one another.

Under the conditions 1 and 2 a rainbow will be seen which will be more or less brilliant as the sheet of falling rain is

nearer or farther off, or according as atmospheric conditions other than the distance, or thickness of the body of air between the eye and the rain-cloud, allow more or less vivid impressions of the rays of coloured light to affect our eyes. The band of coloured light always appears to us as a curve—apparently an arc of a circle; and, although we sometimes only see a small arc, sometimes a semicircle, under special conditions even a complete or nearly a complete circle, and although the diameter of this circle appears sometimes to be greater than at other times, one peculiarity of the phenomenon was noticed from very early times—viz., that the diameter of the circle always subtended the same angle at the eye, and this was about 82° for the middle of the coloured band (Pl. L., fig. 1). The colours of the primary bow are always in the same order, red being outside and violet inside. This circle of light is always so placed that its centre is in the production of the line drawn from the sun through the observer's eye, or where the shadow of his head would fall on the rain-cloud.

It will assist us to conceive more clearly the circumstances if, as Professor Tyndall happily suggests, we imagine a cone, the axis of which is this line from the sun through the head and eye of the observer to the rain-cloud—the apex at the eye, and the base on the rain-sheet. Such a cone, the surface of which would at its base coincide with the ring or arc of *red* light on the outer circumference of the rainbow, has the angle at its vertex about 85° (twice 42½°). A similar cone having a smaller angle at its vertex, of about 81° (twice 40½°), will at its base coincide with the inner circumference of the rainbow of violet light—the other prismatic colours being ranged between them. The centre of the coloured band would coincide with the base of a cone whose angle at the vertex is 82° (or twice 41°), as before observed.

Now, neglecting for the moment the phenomenon of colour, why is it that this luminous curved band is depicted on the rain-sheet? Why does it not reflect to us the sunlight indifferently from all parts of its surface? It is indeed so reflected to us, or we should not see the rain-cloud and falling rain; but why this brilliant reflection on one special curved band?

Descartes was the first who, in 1637, solved this problem. He drew the section of a globe of water, such as a raindrop, though its centre, which, of course, is a circle, and by laborious arithmetical processes he calculated the courses of 10,000 parallel rays of light falling on one side of this circle, being refracted as they entered it, reflected on the opposite interior surface, and refracted again as they emerged (Pl. L., fig. 2); and he found that, while most of these rays were on emergence scattered in various directions, a very large cluster of rays entering at the points S, S, emerged at the points *e*, *e*, parallel

to one another, in the two directions *e* E, *e* E ; and these directions were inclined at opposite angles of 41° to the sun's rays, or of 82° to one another.

This result is true for *all* sections of the sphere or drop of water passing through its centre and in the direction of the sun's rays; from which it follows that, viewing the drop in front (Pl. L., fig. 3), the rays entering on the circle *s*, *s*, *s*, *s*, will be emitted on the circle *e*, *e*, *e*, *e*, and will issue back at the constant angle of 41° with the original direction of the sun's rays, forming a cone or shell of concentrated parallel rays spreading out from the drop of water which forms the apex of the cone, the angle at the apex being 82°, or twice 41°. We can now see how Tyndall's cone, turned the other way, with its apex at the eye and its base on the rain-sheet, coincides exactly with a particular set of strong pencils of parallel rays proceeding from the raindrops which are momentarily situated at the base of this cone: the divergent rays from these particular raindrops converge exactly in the observer's eye, as they start from the precise spots and are directed at the precise angle to reach the eye. All the rest of the rays, whether strong pencils of parallel rays or weaker scattered rays, merely assist in the general illumination or are lost.

Another eye, however, in another position, will see another rainbow formed in the same way by the divergent pencils of brilliant parallel rays from other raindrops which happen to be in the right position to send their rays so as to converge on that other eye.

The special brilliance of the rainbow as compared to the illumination of the rest of the rain-cloud is due to this maximum of parallel emitted rays, which, in accordance with the laws of refraction and reflection of light, emerge in a cone of brilliant rays from each raindrop that the sun shines on; the circular or *quasi*-circular form of the brilliant band follows because the angle at which the light emerges is constant in all directions from the impinging parallel rays of the sun.

The secondary or outer bow often observed is produced in a similar manner, except that the rays which produce it have been twice reflected in the raindrop, as shown in Pl. L., figs. 4 and 4*a*. This double reflection diminishes the force of the light, for each reflection is only partial, a portion of the impinging rays passing out, and consequently the secondary bow is always fainter than the primary bow; but the secondary cones of light act in the same way as the primary, the angle of divergence on each side of the sun's rays being in this case 52°, or the angle at the vertex of the cone 104°. Hence, this bow must be about 11° outside the primary bow.

The colours of the rainbow are due to the varying refrangibility of the coloured rays, which, when combined, give us the

sensation of white light. The laws of the refraction of the different-coloured rays as they pass from one transparent medium into another of different density are known, and the angles at which the extreme visible rays, violet and red, are emitted in the cases of the primary and the secondary bow are noted in Pl. L., fig. 5, from which it will be observed that in the case of the primary bow the less refrangible red rays will reach the eye from raindrops on the outside of the band of light, the violet rays from raindrops on the inside; while in the case of the secondary bow, owing to the second reflection the reverse will be the case, and the outer part of the band of light is violet, the inner edge red.

Two other facts connected with the ordinary rainbow must be noted before we pass to the special cases which are to be discussed: First, that owing to the apparent size of the sun a rainbow is formed by the light coming from each point in the sun's disc: this results in the formation of a number of rainbows superimposed upon one another, and producing the blending of the colours in the spectrum of the rainbow which we always observe. From this also follows a degree of uncertainty in the exact measurement of the angles subtended at the eye by the circles forming the edges of the bows, and of the bands of colour in them. Different observers have obtained slightly varying results. The angles I have quoted can therefore only be taken as near approximations. Second, that, though there is a principal maximum of emergent parallel rays produced, as before stated, both by a single and by a double reflection inside the drop, there are also secondary fainter maxima which produce the spurious rainbows sometimes seen inside the primary and outside the secondary bow, and described in Mr. Harding's paper.

We may now pass on to the case of a rainbow produced by the reflected light of the sun.

An observer in a boat on a calm sheet of water may see on a rain-cloud in front of him not only a primary and a secondary rainbow having the same centre as usual, but also a third bow having its centre at a higher elevation than that of the others. He will ascertain the source of this third rainbow by turning round to face the sun, when he will notice that by reflection a *virtual* image of the sun is seen at the same depression below the horizon as the elevation of the sun itself above the horizon. It is the light from this reflection which produces the third rainbow, the centre of which is in the line inclining upwards from the reflected sun through the observer's eye. If the sun be close to the horizon the sun and its reflection will be so close together that the centres of the primary rainbow and of that formed by the reflection of the sun will nearly coincide, and the third bow may be difficult to distinguish, or it

may only be observed in a slight increase in the width of the band of coloured light, and some blending of the colours at the top of the arc; but if the sun be at some considerable elevation the rainbow formed by the light from the reflected sun will have its centre high up in the heavens, while that of the primary and secondary bows will be below the horizon. (See Pl. LI., fig. 6.)

In Sir David Brewster's treatise on optics published in 1853 he mentions such a third arc as having been observed by Dr. Halley, in 1698, from the walls of Chester, the River Dee, which was unruffled by wind, forming the necessary reflector. Dr. Halley supposed that the third bow "was only that part of the circle of the primary bow that would have been under *the castle*, bent upwards by reflection from the river." He was evidently wrong. By no operation of the laws of optics could such a bending-up of an image which had no existence occur. It was, indeed, the result of reflection on the mirror of the unruffled Dee; but the reflection was that of the sun, and this reflected sun acted as a second sun, and produced a second rainbow. In this case the sun must have been about $5\frac{1}{2}°$ above the horizon when the rainbow was formed (Pl. L., fig. 7), as the top of the arch of the rainbow coincided with the top of the arch of the original secondary bow, and, the colours being in reverse order, this portion of the two bows was white, the two spectra counteracting on each other. Other examples of rainbows formed by the reflection of the sun in calm water are recorded, and the mode in which such appearances are produced is sufficiently simple; but the question as to whether the sun's rays refracted and reflected in the rain-drops may be so reflected again from the surface of a calm sheet of water as to produce in the observer's eye an image of a rainbow in the water, and, if so, what would be the form and colouring of that image, is much more difficult of solution. Professor Tyndall puts the question thus: "Whether a rainbow which spans a tranquil sheet of water is ever seen reflected in the water," and his reply is, "The rays effective in the rainbow are emitted only in the direction fixed by the angle of 41°. Those rays, therefore, which are scattered from the drops upon the water do not carry along with them the necessary condition of parallelism, and hence, though the cloud on which the bow is painted may be reflected from the water, we can have no reflection of the bow itself." Of the *bow itself*, you observe; but he does not say of any other bow that a reflection is impossible. Of the bow itself it is evidently impossible; for, think only of the concentrated parallel rays which produce in our eyes the impression of the highest point of the arch: they come directly from the raindrop there to our eyes, and therefore cannot touch the water and

be reflected to our eyes. The particular raindrops at that part of the falling sheet of raindrops send their effective concentrated parallel rays direct to our eyes, and produce the brilliant image apparently at that spot, and, although scattered rays from that raindrop may reach the water at the right angle to be reflected to our eyes, they will be weak, scattered rays, and will not produce any effect beyond that of general illumination of the water. And the same is true of the particular raindrops forming the image in our eyes of any part and all parts of the rainbow we see. But the question arises, Are there not other raindrops at other parts of the rain-sheet the *effective* parallel rays from which, falling on the surface of the water, and reflected therefrom, will reach our eyes and produce there the brilliant sensation of a rainbow reflected in the water?

Professor Tait, in his treatise on light, puts the question and the answer in this way: "Can *a* rainbow be seen by reflection in still water?" "To this, of course, the answer is that a spectator sees, by reflection in still water, *the* rainbow he would have seen had the water been removed, and had his eye been at the position formerly occupied by its image in the water." He adds, "But a reflected rainbow differs from a rainbow seen directly, in the fact that, as the light forming the latter is partially *polarised,* the intensity of the former is modified differently at different points in the act of reflection." His reply therefore is that *a* reflected rainbow *can* be seen, though, as before observed, it will not be a reflection of the particular rainbow perceived by direct vision. And, although his reply is not quite easy to understand, owing to its extreme brevity, it gives the key to the solution of the question. The diagram (Pl. LI., fig. 8) will explain. By the words "its image" he means the image of the observer's eye as it would be reflected in still water vertically beneath it, where it would appear to be as deep below the surface as his eye was above it. The geometrical construction shows that a line from this point at an angle of 41° with the direction of the sun's rays cuts the water-line at a point where a ray, proceeding from a drop in the rain-sheet at an angle of 41° with the direction of the sun's rays, would be reflected to the observer's eye, the angles of incidence and reflection at the surface of the water being equal. The ray reflected to the eye would give an image of the highest point of a rainbow which would appear to be at the same distance below the surface of the water at the rain-sheet as the drop which emitted the ray was above it. Knowing that the centre of the circle must be at the point where the parallel sun's ray, passing through the reflected image of the eye, cuts the vertical rain-plane (produced below the surface of the water), we have no difficulty in describing the arc of the rain-

bow that would be seen from the position of the reflected eye, and in drawing its reflection which might be seen by the actual observer.

It will be evident that the lower and nearer to the reflecting surface the eye of the observer, the less will be the distance between the eye and its reflected image, and, consequently, the locus of the invisible rainbow to be seen by reflection will more nearly correspond with that seen by direct vision, and the reflection would seem very like a reflection of the visible rainbow were it not for the polarisation of the rays emitted from the raindrops after reflection and refraction. This polarisation has been found to correspond with the radii of the arch. Thus the light coming from the summit of a semicircular arch would be polarised at right angles to the light coming from the feet of the arch, and the direction of polarisation would change gradually between these points. The polarised rays from the top of the arch would, I think, be more strongly reflected than those from the sides, and I should therefore expect to see the lower part of the inverted reflection more distinctly than that of the sides.

The question still remains, Has any one ever seen such a reflection? I can trace no record of such an experience, and I attribute it to the fact that almost always the surface of the water is strongly illuminated by the sun when a rainbow is formed over still water, and that, consequently, the refracted and reflected rays which would form this reflected image are overpowered by the strong illumination of the water-surface. To see distinctly the reflection of a bright object in a mirror, the mirror itself must be in comparative shade. This condition might be produced by the shadow of a ridge of land, however, and, although the meteorological conditions at Wellington are rarely favourable to the exhibition of a rainbow reflection in calm water, yet, were a shower to fall over the harbour towards sunset without wind, the shadow thrown by the hills on the west of the harbour might enable us to observe the evidently very rare but *possible* phenomenon of an inverted rainbow seen by reflection on the water. From a yacht becalmed in mid-harbour, or from Somes Island, the bow, or bows, formed by the sun reflected in the calm water might be observed.

In considering the subject of rainbows geometrically, I was at first led to the conclusion that they must often appear not as arcs of circles but as portions of ellipses. I have not seen any allusion to this in books, nor had I hitherto thought of looking for or expecting any such distortion of the circular arch, but I think there can be no question that wherever the raindrops emitting the pencils of parallel rays which reach our eyes are not equidistant from the eye they cannot lie in

the arc of a circle; and this must be the case whenever the rain-sheet is inclined towards or away from us by wind, or when one side of it is farther from us than the other, or, finally, when the sun is comparatively high above the horizon, and the rain-sheet is vertical. In all these cases the cone having its vertex at our eyes, and its axis in the line from the sun, through our head and eyes, to the rain-sheet, must be intersected by the rain-sheet in a plane to which the axis is not perpendicular, and the intersection must be the conic section known as an ellipse.

In Plate LI., fig. 9, the geometric elevations of the rain-drops forming two rainbows are shown as they would appear if occurring when the sun's rays were nearly horizontal, soon after sunrise or sunset: $b\ a_{\prime}\ c$, a semicircle on a vertical rain-sheet, and $b\ a\ c$, an elliptical curve with the major axis vertical, occurring on a rain-sheet inclined by the wind 15° from the vertical.

In Plate LI., fig. 10 are shown the geometric elevations of the rain-drops forming two rainbows—one, $a_{\prime}\ o\ b_{\prime}$, a semicircle, as before; the other, $a\ o\ b$, a semi-ellipse with the major axis horizontal, formed on a rain-sheet oblique in plan to the sun's rays, the ellipse being thus thrown altogether towards the side where the rain-sheet was most distant.

In Plate LI., fig. 11, are shown similarly the geometric elevations of the drops forming two rainbows as seen from the top of a mountain 8,000ft. high, the rain-sheet being vertical and about 8,000ft., or, say, a mile and a half, distant. In this case, if the sun were near setting, and the sun's rays consequently nearly horizontal, the rainbow would appear as the geometric elevation of the raindrops forming it, a complete circle, excepting the part obscured by the shadow of the mountain—were the observer in a balloon the circle would be complete. And it is to be noted that great altitude is not required in order that a circular or nearly circular rainbow may be observed*—the conditions are that the elevation shall be about the same as the distance of the rain-cloud from the observer.

In this same figure (fig. 11) is shown the elliptical geometric elevation of the raindrops forming the rainbow which would be observed under the same conditions except that the sun is higher up in the heavens, the axis of the cone having thus become oblique instead of perpendicular to the plane of the rain-sheet. The rainbow would, however, appear as the lower and less complete circle.

* The curvature of the earth has but little influence on the result: at 10,000ft. altitude only about 2° of depression would be given to the sun when setting or rising.

For in all cases the appearance to the observer must be that of a circle or an arc of a circle, whether the raindrops emitting the rays which reach his eye be arranged on the surface of the rain-sheet circularly or elliptically, because they must, from the nature of the case, reach the eye from all directions at the same invariable angles to the sun's rays, and form their picture on the retina of the eye, which is practically a plane to which the direction of the sun's rays is perpendicular, and thus the ellipse is projected as a circle in the eye.

This invariableness of the direction of the rays explains also why it is that we see, as an even arc of a circle, rays coming from an uneven surface of rain-sheet, for doubtless the rain-sheet producing the rainbow is almost always undulating in broken curves corresponding with the irregular edge of the rain-cloud from whence the rain is falling, and some of the drops emitting their cones of brilliant light must be farther off than others in an irregular manner. The eye is only capable of giving information as to the direction and the brilliancy or force of light, just like a theodolite or other optical instrument, and we do observe variations in brilliancy in different parts of a rainbow, which no doubt result from the greater or less distance from us of the raindrops emitting the light. Such variations in brightness are noted on figs. 9, 10, Plate LI.

THE BIRTH OF A RAINBOW.

The sun-born waves of heat stirred with tumultuous force
The liquid water; atom from atom moved apart
In active vaporous rhythmic dance, mingling with air
And gravitation's mighty balance bore them up.
Hither and thither, upwards, downwards they were swayed,
Until a colder and less active air was met,
In warming which themselves lost heat and shrank to water back.
By gravitation urged the liquid drops were formed,
Each one a globe, and all to earth attracted fell.
Now light-waves struck the falling globes, and, ruled by law,
Were bent and sifted, and streamed back, cone within cone
Of brilliant-coloured light from all these tiny globes.
Perchance a human eye beheld the falling rain,
And from those countless cones of coloured rays some strike
His eye, from this side, and from that, and from above,
But all at the self-same angle of self-same hue;
And thus was pictured in his eye the coloured arch
(It may be two), and he *perceived* the glorious thing.
A human mind,* a seeing eye, matter and light,
Heat, gravitation, all combined to bring it forth.
But trace it one step farther back. Whence came all these?
Who formed and ordered them together so to work
In perfect harmony? In the beginning God—
His mighty will, the energizing power still.

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* Has any one ever observed an animal (other than man) looking at, or taking notice of, a rainbow?

APPENDIX.—At the request of Mr. Harding, I add a figure (Plate LI., fig. 12) which shows how pencils of parallel sun's rays, entering the raindrop at *a*, *a*, after refraction, three reflections, and refraction again, issue at *b*, *b*, at an inclination of about 65° away from the original direction, and parallel to one another. These rays would, under very favourable conditions, be powerful enough to be visible, and would form a third rainbow, concentric with the primary and secondary bows, and at a distance outside the secondary bow about twice as great as the distance of the secondary from the primary, as shown in fig. 13, Plate LI. The order of the colours in this tertiary bow would be the same as in the primary, and it would be broader and fainter than the secondary bow. This is what I should expect to see from geometric construction; and I imagine that it was the tertiary bow so formed which Mr. Harding observed and described in his paper.*

I am unable to grasp the idea suggested in Mr. T. B. Harding's note that a rainbow could be projected on a clear sky by the sun's rays diffracted in passing through a granulous cloud. I do not see how the essential conditions for the formation of the picture of a rainbow in the eye of an observer looking at this clear sky could occur under such circumstances. I imagine that rain was really falling there, although not noticeable by the observer.

ART. LXIV.—*Sanitation and Ventilation as required in a Modern House.*

By EDWARD WITHY.

[*Read before the Auckland Institute, 3rd October, 1892.*]

Plates XLVIII. and XLIX.

IN dealing with these important subjects, I wish at the outset to make it clear to the audience that I do not presume to speak as an expert either in the designing or executing of the works required. It may therefore prevent some misapprehensions, and open the door to freer criticism from amateurs like myself, if I state that, merely from a desire to insure healthy conditions in several houses which have been built or altered for my personal occupation, I have been for some years a reader and inquirer in the regions to be explored.

* See above, Art. LXII.

Such very defective practice exists in almost every house that, although an amateur, I offer no apology for venturing to point out some of the dangers to which we are exposed, or for suggesting what appear to be improvements. General interest in these questions was greatly stirred by the attack of typhoid fever from which the Prince of Wales suffered some twenty years ago. This has grown, until several associations have been formed in England for the purpose of sanitary inspection, and numbers of men have qualified themselves to act as sanitary specialists, whilst some City Corporations have adopted the wise practice of retaining the services of such men as permanent public officials. It will be almost impossible for me to acknowledge every source from which I have drawn the remarks which follow, but, in default of this, let me say that no part of them has originated with myself. I have therefore no patents to recommend, and no special make of appliances to advertise, but will deal impartially with whatever I have examined or tried, speaking merely as a purchaser and user of such articles as are usually offered to householders.

Without further preface, I will begin to deal with the first division of the subject, viz.,—

Sanitation.

In doing so, I propose, before plunging into details, to speak of some general principles, the fuller understanding of which has led to great reforms in the older system. I well remember that the country-house in which the Prince of Wales contracted his illness was said by the newspapers to stand in an elevated position, and was considered to occupy a most eligible site for general salubrity. Owing to the slope of the grounds it was supposed that the drains would have every chance of carrying away rapidly, and to a safe distance, all the waste which might prove injurious to health. Yet, in spite of these supposed advantages, it was believed that the source of danger was a water-closet near to the Prince's apartments. It was afterwards clearly ascertained that this was the fact, and it was soon evident that, from want of knowledge of the true principles of sanitation, the favourable situation of the house had been allowed to become its greatest danger. Up to this time it had been generally, and, indeed, is still very often, the aim of the plumber to make an air-tight connection between the water-closet and the soil-pipe, and to lead the latter, in a bottled-up condition, direct to the public sewer or to a cesspit. In the same way he carried some of the waste-water pipes into the soil-pipe, in the belief that their discharges would cleanse it, whilst at the same time they would themselves be carried away by the most effectual means at command—viz., the air-tight system of pipes. If each of

these pipes was carefully trapped it was supposed that no return of foul air could take place, and so every one slept in peace. The important condition of the problem, which had so far been overlooked in making the arrangement in this way, was the fact that the pipes were not constantly full of water but of air. From its lightness, the air necessarily fills all the spaces from trap to trap, whilst the water flows down to the lowest level which it can find. The air, of course, becomes polluted by the frequent passage of discharges, and by constant contact with the dirty pipe. "Evil communications corrupt good manners." Whatever disease-germs may be present will thus be carried about, not only by foul water, but by the air which it has contaminated. It soon became evident to some who studied the subject that when the pipes were thus charged, if any water was poured into one of them, it would, owing to its superior gravity, fall through the air, and either cause the immediate displacement of an equal bulk of it, or produce a temporary increase of pressure in the pipes. This pressure would be gradually relieved by the escape of air and water until the normal condition was resumed. Now, the all-important question was, "In what direction will the immediate displacement or gradual escape of this air take place?" If it went downwards with the discharged water, and passed through the several traps into the drain or cesspit, all might be comparatively well. But obviously this could not take place. In such a race the heaviest fluid must necessarily win the race, and, in its descent, must force *upwards* most of the air which was stationary in the pipes. At the best, the water could only force before it, or carry along with itself, a small portion of the air, leaving the greater part to reascend the pipes and force its way, until the normal condition of pressure was restored, through one or other of the traps. Nor is this forcing of its way through the water in a trap, which some from want of experience may say is impossible, its only way of escape into the house. This airtight system of pipes involves other dangers, one of which is that the water may be siphoned out of any trap by the sudden discharge of a large quantity of water, either through itself, or down some other pipe of the same system. If such a body of water rushes impetuously down a nearly vertical pipe, temporarily forcing onward some of the air, it must produce a partial vacuum behind itself. The inrush of air from the house to fill this vacuum will often be strong enough to carry with it so much of the water which was lying in the trap as to leave a free passage for the subsequent ascent of the foul air. When this ascent takes place, if it happens that the waste-plug or valve has not been returned to its place immediately after the discharge has passed away, the foul air will slowly

float upwards into the house and become a source of danger to health. If it becomes at the same time a cause of offence to the nostrils, we may congratulate ourselves, because we shall be warned of what has taken place. Another danger is that mere evaporation from the trap of some discharge-pipe which is seldom used may leave an unobstructed passage for foul air to enter the house.

When this fuller knowledge of the conditions of the problem was properly realised it was soon seen that the air-tight system must be given up. This abandonment must not, however, be understood to indicate an indifference to the presence of leakage in the pipes or drains. So far from this, freedom from leakage is now more carefully guarded against than formerly, and, in order to secure it, better materials and more perfect jointing are demanded. In considering how to provide a vent for the air displaced by every discharge of water into the pipes, it became necessary to guard against the possibility of its entering the house. It was seen that the vent for it must be carried above the highest window, above the eaves, and even above the joints of the slates. A simple method of doing this was to carry the soil-pipe, or a smaller continuation of it, upwards to the ridge of the roof, or to a stack of chimneys, instead of stopping it at the highest water-closet. Another step in advance was to form a free inlet for air at the bottom of the soil-pipe. By these two improvements a current of fresh air was made to pass constantly through the whole length of the pipe when not being used, and this would render any accumulation of injurious air impossible. When a soil-pipe so fitted came to be used, the discharged water would encounter nothing to retard its exit. The air below the descending water would be forced forward through the lower opening, and that above it would freely yield to the downward suction. This would prevent the risk of the demand for air causing the water to be sucked out of the traps. It will be seen also that each of these openings acts as an inlet or an outlet, as occasion demands. Plate XLIX., fig. 1, shows a soil-pipe ventilated in the way described.

The next step in the direction of improvement is to disconnect all water-wastes from the soil-pipe. It must be obvious that the connection of these with a soil-pipe connected with a drain will bring many further dangers of contamination to the air of the house, because it means that openings are provided into other rooms than the water-closet—into rooms, indeed, where bathing, washing-up, and cooking are being done. Such connections, therefore, not only bring *additional* dangers, but *greater* ones, because of the longer time during which the air of these rooms is breathed by the occupants of the house. The

cleansing which water-wastes may effect in the soil-pipe by their discharges is very small, and this is the less necessary after the pipe has been opened at both ends, and especially as thereby its own discharges will better than formerly effect the purpose now that they get away more rapidly. There being, then, no valid reason for continuing such a plan, it was seen to be much better to carry each water-waste, or several combined, through the wall of a house, and to let the end project over, and discharge in the open air upon, an ordinary grated sink connected by a good trap to the drain. By adopting this arrangement we get (1) a free inlet for air at the bottom of the waste-pipe, and (2) an entire severance of it from the drain. All such wastes should be well trapped at the top, because the pipes necessarily get foul, and will consequently emit tainted air. In the event of two or more wastes running into the same main pipe an upper air-inlet also must be provided, lest the discharge rushing down the main pipe should suck the water out of one of the traps. In the case of any discharge which may be a heavy one, as from a bath or slop-sink, such an inlet should also be provided to prevent it from untrapping itself. In all such cases there will be the additional advantage of a free current of air through, as described in the improved soil-pipe. There is not the same urgency for this, but where first cost does not stand in the way it is very desirable. A good plan is to carry the waste-pipe itself up, and out through the wall a little above the highest vessel to be discharged.

The rainwater pipes should never be connected to the drains, but should either discharge upon such a grating as that just described, or else into an open channel communicating with one. Where they are connected to a drain the foul air will flow up them in dry weather, and may enter a window or find its way in at the eaves or under the slates. On one occasion when visiting at a friend's house in London, in the summer-time, I left the bedroom-window open, and woke in the night to find the room filled with the vilest smell. In the morning I looked out of the window to discover the probable cause. Underneath was the top of a bay-window, with a small and innocent-looking pipe in one corner to carry off the rain. My host got a plumber at once, and found that this pipe was carried direct, without any trap, into the drain which led to the main sewer in the road. The small pipe was made of zinc, and was perfectly blackened inside by the foul gas for which it may have been for years the principal outlet. The danger in such cases, however, is not confined to houses connected with public sewers. In a house to the sanitation of which I had devoted much care, and which had its own cesspit, I noticed a bad smell on the top of the porch. The London experience

occurred to me, and I went at once to the head of the rain-water pipe. There was a most offensive odour rising from it. The tops of two bay-windows were fitted in the same way, and above each there was a bedroom-window. I found the rain-water pipes connected directly to the drain, and had them at once cut off above ground, so that they should discharge into the open air. The reasons which make foul air so ready to enter a house will be dealt with presently under the heading of "Ventilation." Plate XLIX., fig. 2, shows a system of water-wastes arranged in the way described. As each principal part is named, it will probably explain itself pretty fully.

The next point with which I will deal is the connection of the soil-pipe with the drain. This should be done in such a manner as to insure the carrying-out of the same principle as that adopted in connecting the water-closet and soil-pipe. This principle is the prevention of the escape of foul air from the pipe into the house when each discharge is made. In the case now under notice we must similarly prevent the passage of foul air from the drain into the soil-pipe. The trap which forms the connection must not therefore be of the old air-tight description, but must contain a vent open to the air from the house-side of the water-seal of the trap. If such an opening is provided it will prevent any foul air from passing into the soil-pipe, because it supplies an easier outlet. This opening will at the same time answer for the fresh-air inlet required at the foot of the soil-pipe. Care must of course be taken that this vent shall not be directly under, or near to, any of the windows of the house. Plate XLIX., fig. 1, shows the position of this intercepting trap, and Plate XLVIII., fig. 1, gives a detail of it.

The final point of importance is the ventilation, where practicable, of the drain connecting the house with the main sewer. This will not be possible in a public street, but there are many cases where a house stands well back from the road, and others where there is a private cesspit in the grounds. To insure real ventilation, here as in other cases, an *outlet* merely is not sufficient, but an *inlet* must also be provided. Both should be kept well away from windows or much-frequented paths, and the outlet should be carried up as high as possible. An exhaust ventilator on the outlet, and an inlet ventilator, such as a cowl arranged to keep its *mouth* instead of its *back* to the wind, will greatly add to the efficiency of the ventilation. Of the two arrangements possible, the better one would be to have the inlet at the end near to the house and the outlet at the distant one.

In endeavouring to make sanitary arrangements, do not be deceived by the supposed efficacy of deodorisers when applied to the various openings. It is not the mere smell of the foul

air which we wish to remove, but to prevent the entrance of the disease-germs which it carries with it. Foul air requires constantly diluting with pure air, and at the same time carrying away to a distance from our houses and our lungs. Disinfectants, when used in connection with drainage, are mere useless shams. If there is any foul air entering our houses we had better know of its presence by the smell, and then take effectual measures to stop its entrance. Do not let us be guilty of the folly of allowing it to come in and then using mere palliatives to drown the voice with which it warns us.

The foregoing pages may serve to describe, and to explain the reasons for adopting, an improved design for our systems of sanitation; and I will now deal with details of construction, and offer criticisms upon some of the appliances in common use. It will be self-evident that the very best design may fail from the outset if the details of construction are faulty.

House-drain.

The drainpipes leading from a house, whether to a cesspit or to a public sewer, should be constructed of earthenware socket-pipes glazed inside and out. They should never be built of brick or stone, for the following reasons: (1) It is almost impossible to make them tight, and (2) quite impossible to keep them so; (3) their inner surfaces are always more or less rough, and, as a consequence, they retain portions of the discharges and become very foul; (4) they cannot be made, when of a small size, of the best sectional form for allowing a good flushing effect to the liquids discharged into them.

An error in laying drains, and one formerly very common, is to make them too large in diameter. It is now considered better to make them as small as possible consistent, of course, with their ability to carry off the discharges. The reason is that the flush of water, being more concentrated, goes through with greater speed and force. It thus keeps the drain cleared, and also comparatively clean. If a 4in. pipe will do the work, a 6in. should never be used. In most ordinary dwelling-houses the best authorities agree that the former is ample. The area of a 6in. pipe is two and a quarter times that of a 4in., and is only necessary in a large house having more than two water-closets.

The next important matter is the jointing of the pipes. The first point to attend to is to keep the socket end uphill, and the second to see that the next pipe lies fair and straight in it. If a sharp turn is required, a bend exactly suiting it should be used. If a gradual curve is necessary, probably a little care in selecting those pipes which have not been made

quite straight may be sufficient. All the pipes should be solidly bedded, and a small trench made under each socket to give free access for filling the lower side of the joint. The second point is the proper filling, without leaving any of the material to project inside the pipe to form an obstruction. To prevent this, a small gaskin of hemp, dipped in liquid cement, should be fastened round the pipe, and pushed home to the bottom of the socket. When this is done the socket should be well filled all round with Portland cement, nicely finished off, taking as much care with the under part as with the upper. It is further desirable to insert a well-padded and close-fitting plug, called a mouse, into the first pipe, and, by means of a strong cord, to draw it forward past each joint after it is made. This will wipe off any cement which may have oozed past the gaskin. Clay is often used for filling, but there are several peculiarities which render it unfit for a jointing material. First, it shrinks in drying; second, if it is not very hard the weight of the pipes may cause them to compress it on the under side, and thus form a vent on the upper; third, both these defects, by enabling the water to commence a run, lead to the clay-filling being constantly reduced, with the frequent result of undermining other parts which were perfect, and ultimately causing the collapse and stoppage of the drain; fourth, and worst of all, it is possible for fibrous roots to find their way through the clay and choke the drain.

There are several reasons which make it desirable that drains should be tight: (1.) They are often under a house, and always come close to its walls. (2.) If they leak the liquid will impregnate the ground and cause an unhealthy condition. (3.) It may contaminate the water of a well, and produce typhoid fever. (4.) Foul gas may arise and be attracted into the house by the warmer air. (5.) The escape of the liquid reduces its flushing-power, and therefore increases the deposition of sediment, so that the risk of the drain becoming stopped and the certainty of its becoming fouler than otherwise are rendered greater. In cases where it is necessary to lay a drain *under* a house it should be entirely bedded in and covered by cement concrete so as more effectually to guard against leakage or the cracking of a pipe as the result of settlement of the ground or foundations.

Wherever a branch has to be connected to a drain it should be done through a socketed junction-pipe, set at the proper angle, and entering in the direction of the fall of the drain. The insertion of a branch into a hole chipped out of the drain should never be tolerated. It is difficult to make tight; the broken chips enter the drain, and the end of the branch is very likely to form a permanent obstruction. A proper junc-

tion-saddle should be procured and cemented to the drain in these cases, great care being taken in making the hole.

Intercepting-trap.

Having laid the house-drain properly, the next thing is to choose an intercepting-trap through which the soil-pipe may enter it. Plate XLVIII., fig. 1, shows such a fitting. Probably the best material for this is glazed earthenware, because, being of the same material as the drain, a perfectly tight cement joint can be made. This trap serves the double purpose of preventing air from the drain entering the soil-pipe, and at the same time of providing a fresh-air inlet to the latter. It must be placed outside of the house in every case, so that an efficient air-inlet can be provided direct to it. In addition to the air-vent and inlet, this fitting must embody two other features, viz.: (1) A sufficient water-seal, and (2) a good drop from the entering-pipe to the surface of the water lying in the trap.

Soil-pipe Ventilator.

The trap just described provides for the admission of fresh air at the foot of the soil-pipe. This must be supplemented by an outlet above the windows, and, if possible, above the ridge of the roof. When so constructed the air will be able to pass through the whole length of the pipe, and thus to prevent any accumulation of injurious or even offensive air. It will be an improvement to put a good extracting ventilator upon the top to increase the air-current. Of the two methods of providing an outlet on the roof I prefer that which is shown in Plate XLIX., fig. 1. It consists in carrying up a 2in. galvanised-iron pipe, with soldered joints, inside the house, from the outside of the trap under the water-closet. If there is a second closet its ventilating-pipe can be branched into the main one. A thorough test of the tightness of these pipes should be made by filling them with water.

Water-closet.

There are many styles of water-closets; but I think that none of them can compare with the modern ones which are made entirely in one piece of glazed earthenware. Any valves or movable pans are objectionable, from the certainty of their fouling, and from their liability to leakage either from that cause or from getting strained. The old pan-closet with the capacious trunk under it is simply an abomination, without a single redeeming feature. It has been wisely condemned at Home by the Local Government Board. There are two other, and more modern, valve closets which were designed to avoid some of the objections to the old one, but they do so very im-

perfectly, and are at the same time more expensive than the simple earthenware form. No valve closet is convenient for pouring a large pailful of slops down, because the valve presents an obstruction, even if held up, which is not an easy operation to perform while pouring. There are two principal varieties of the closet recommended, which are generally distinguished as the "wash-down" and the "wash-out" closet. On Plate XLVIII., fig. 2 shows a section of the former, and fig. 3 of the latter. For the former it is contended that the force of the flush goes directly downwards into the trap and carries all before it more effectually than it can do in the latter, in which it first discharges into the pan, and then flows over the rim into the trap. I am inclined, notwithstanding this, to prefer the latter, because, owing to there being a larger surface of water immediately under the centre of the pan, its sides are less likely to become soiled. It will be seen that both of these closets are of the simplest possible construction, and that as long as they remain unbroken, and are used frequently enough to prevent the water in the trap from evaporating, it is absolutely impossible for any return of foul air from the pipe to take place. Even if the water-seal should be destroyed by evaporation such air from the drain would find a readier exit upwards through the ventilating-pipe rather than by descending between the lips of the trap into the pan. There is also the minimum of surface, and that of the smoothest, for any foul matter to collect upon, and there is no mechanism to get out of order.

The closet should always have a flushing-pipe not less than 1¼in. diameter, which should come from a waste-preventer cistern, separate from all others, holding not less than two gallons of water, and placed at least 6ft. above the closet. The use of a separate cistern will prevent the possibility of contaminating any water used for drinking or washing. It should be placed in the room, where it is always accessible, and not above the ceiling.

To insure the most wholesome closet arrangement the wooden casing round it should be entirely dispensed with, and only a hinged flap should be provided as a seat. By adopting this plan it will, when the lid is raised, serve the purpose of a slop-sink and urinal as efficiently as anything that could be contrived for these uses, and will at the same time save the space and extra cost of providing and fitting them. If expense does not stand in the way a very nice addition is to cover the floor and surrounding walls for a short space with glazed tiles set in cement. You have then the most perfect arrangement, in my humble opinion as a householder, which has as yet been suggested by the experts.

The detailed arrangements which have so far been de-

scribed are brought together, and the separate parts named, on Plate XLIX., fig. 1.

Waste-water Pipes.

These are required to discharge the contents of baths, lavatories, urinals, and sinks. They should be kept entirely clear from connection with the soil-pipe. This may seem superfluous, in the opinion of some who have followed me in the description of a modern soil-pipe, however desirable it might be to separate them from one of the old style. But we must bear in mind that plumbers are mortal like ourselves, and do not always perfectly execute what has been well designed. We must also remember that materials always decay, and may be damaged by accidents; and, further, that the best thoroughfares sometimes get blocked. Danger may arise from any of these contingencies happening, and it is always well to make assurance doubly sure, especially when the cost of doing so is not great. There can be no danger in carrying several of these pipes into one, provided the area of the main pipe is made sufficient. There should always be a trap, formed as an S bend, in the pipe pretty close up to each vessel to be discharged. At the lowest part of the bend of the trap a brass screw-plug should be fitted for the purpose of cleaning out the sediment, and for readily getting at any obstruction. Plate XLVIII., fig. 4, shows such a bend, with screw-plug. A grating should be fitted over the top of the pipe to detain any pieces of refuse which may find their way into the vessel. In order that the clearway of the aperture shall not be too much reduced by this, the pipe should be widened out at the top to take a grating rather larger in diameter. The waste-pipe should then be carried through the wall and made to discharge in the open air above an earthenware sink-trap fitted with a galvanised-iron loose grating. This will cut off all connection with the drain, fresh air will flow freely into the pipe, and the waste will be discharged more quickly, because the vent is not choked as it would be if it opened out into the water of another trap. Cast-iron traps, of whatever form, are objectionable, owing to their liability to become perforated by corrosion, and owing to the roughness of their inner surfaces compared with those made of lead or glazed earthenware. Where a good deal of cooking is carried on it will be advisable to have the outside trap fitted with a removable tray which shall retain the grease: such a trap is shown on Plate XLVIII., fig. 5. In the absence of such a provision every trap should be made self-cleansing—*i.e.*, constructed without corners, pockets, or rough places. The size of traps can only be determined by the amount of waste which they are expected to carry off.

When several wastes are connected to one main pipe the best plan to ensure sweetness is to carry the latter up a foot or two above the top of the highest vessel to be discharged, and to pass it out through the wall, and leave the end open. It will then be fully open at both ends like the soil-pipe, but, unlike it, does not need to be carried to the top of the house.

Rain-water Pipes.

Rain-water pipes should never be connected to the drains, but be made to discharge over a sink-trap, or into an open channel running into one. When the rain is collected in a tank the overflow from it must be treated in the same way, in order to guard against the possible contamination of the water by sewer-gas. Plate XLIX., fig. 2, shows the general connection of all these details.

From a sanitary point of view it may be scarcely necessary to speak of the supply- and waste-valves fitted to the various vessels used for washing. My own experience, however, leads me, after trying for many years some of the most attractive modern appliances, to revert to the simple screw water-taps, with their unions well exposed, and to the plain plug-waste of a large size, with grating or cross-bars fixed beneath. Part of the cost thus saved may, however, be very well spent, in the interest of cleanliness as well as taste, in having all visible parts of the fittings carefully electroplated. It may be well to add that it is decidedly in the interest of sanitation that all these necessary appliances and the apartments which contain them should be designed carefully for their several uses, and made to look cheerful and attractive; nothing put in more than is needful; no covering on the floors fitted close to the walls or tacked down, lest it may retain wet; and no unnecessary draperies, because they will harbour dust. I would have no wood covers, or even margin-pieces, round the tops of sinks; nor have any cupboards fitted under them, or under lavatories, but would support them all with neat brackets. The lavatory waste-pipes can be made with more care, and painted. Dirt, damp, and decay, with the smell resulting from their presence, can thus be exorcised—for they are indeed *evil spirits*.

In the bath-room a self-contained bath, not cased in but with its upper edge rounded over, standing upon suitable feet on a leaded portion of the floor, and surrounded with glazed tiles on the walls, extending from the floor to 18in. or 2ft. above its rim, would be attractive even to a fairy, because a glance would enable her to see that nothing insanitary existed in the shrine devoted to her ablutions.

Having strayed into the regions of romance, it may appear to be high time that I should close this portion of the paper. Indeed, there is very little more that I can say beyond urging

the necessity of taking great care to prevent stoppages occurring in any waste-pipes, and pointing out that periodical examination and testing are most desirable. I should very gladly join an association for the purpose of employing a competent expert to go round at stated intervals to see that the domestic arrangements of its subscribers were in perfect order. We have lately seen that Germany with all its immense expenditure upon preparations to meet foreign foes and while proposing a large increase of armaments was, in the bad sanitary condition of two of its largest cities, courting the advance of epidemic disease, and, as far as its hospital-accommodation went, was totally unprepared to protect its citizens from the foe after he had crossed the border. To be forewarned should be to be forearmed.

Lastly, no attempt to deal with sanitation would be complete which omitted to deal with water-supply to our houses. Whether this is obtained from public water-mains or is caught in tanks from our roofs, every care should be taken to keep it free from contamination of every sort, and even from the suspicion of it. If it is stored in tanks they should be cleaned out periodically. In either case the water which is used for ordinary drinking—*i.e.*, such as will not be boiled—should be passed through an efficient filter. The replenishing of this should be the regular daily duty of some one in the household: what is every one's duty is likely to be neglected. The filters themselves require washing out occasionally by being laid sideways and having water run through them in the opposite direction for some time.

VENTILATION.

I will commence this part of the paper, as I did that upon sanitation, by considering the main facts affecting the movements of the element which we have to deal with—viz., the air. In sanitation we had to consider the action of two different fluids—water and air—when passing through pipes; in ventilation we have to consider the action of only one fluid—air—when circulating through a house. The movements of the atmosphere are caused by the heat of the sun, and the familiar explanation of the cause of the trade-winds will serve as a good illustration. When air is warmed it becomes lighter, and consequently floats upwards. The greater heat of the tropics causes the air in those latitudes to rise, and thereupon the cooler air, for some distance northward and southward, flows in to take its place. This process is continually going on, and would result in a prevalence of northerly winds in the Northern Hemisphere and southerly winds in the Southern if it was not for another tendency produced by the revolution of the earth upon its axis. The earth is continually

revolving from west to east, and, as the atmosphere is not carried round at the same speed, there is a tendency to produce a current in the opposite direction—*i.e.*, from the east. These two movements combined cause the air-currents to take a middle course, and to form in the Northern Hemisphere the "north-east trades" and in the Southern the "south-east trades."

The only part of this illustration which will help our present investigation is the first part—viz., that which shows (1) that warm air will always rise, and (2) that cold air will readily flow in to take its place. The law which governs this action is simply that which causes water to seek its own level. The reason of the latter tendency is that, when water and air together are drawn downwards upon the earth's surface by the attraction of gravitation, the water, having a greater specific gravity than air, is drawn to the lowest parts, and displaces the air from them. But, if quicksilver was also in the race, it would as speedily displace the water. This law, then, is universal in its operation, and causes all fluids to range themselves in horizontal layers according to their specific gravities—the lighter at the top and the heavier at the bottom. Now, warm air is of less specific gravity than cool air, and therefore floats above the latter, and, for all purposes with which ventilation has to do, acts just as if it was a distinct fluid.

Having realised that the law governing our problem is simply that of gravitation, let us apply it to the conditions which we know exist in connection with a house. We are all conscious that the average temperature of the air inside a house is greater than of that which is outside. It must follow that there is a constant effort being made by the inner air to float out at the *higher* openings, and by the outer air to flow in at *every* opening, whether *high* or *low*. A simple illustration will make this action clear: Supposing it to be possible to lift a house bodily, and to immerse it suddenly in a lake of water, the result would be that at all the joints of doors, windows, and slates, under the eaves, and down the chimneys water would commence to flow in. The air would at the same time begin to escape and to bubble up to the surface. A little consideration will show, however, that it would not come out of the house at every opening at which the water was entering. As soon as the water rose on the inside of the house above any opening, that opening would cease to emit air, because it would always be impelled upwards and never downwards. If there were no outlets from the rooms above the tops of widows or doors a quantity of air would be imprisoned in them as in a diving-bell. To make this illustration apply to ventilation we have only to substitute outer (or cool) air

for water, and inner (or warm) air for air, and to remember also that the air which flows into a house is being continually warmed, and caused in its turn to float out, to see that this is the constant operation which gravitation tries to carry on in a house.

To pass from this illustration, another fact must be borne in mind—viz., that the various openings into a house are constantly acted upon by the varying currents of air which are moving outside. The effort of the cool air to get in at some openings from which warm air is trying to escape, coupled with the baffling influence of outside currents, constitute the principal difficulties with which we have to deal. These efforts which Nature makes to prevent a stagnation of air in any part of her domain do, within certain limits, ventilate our houses. Why, then, should we not be content with what Nature does? The answer must be that her efforts are too rough-and-ready, and therefore need regulation in order to adapt them to our requirements.

Before attempting to regulate them we must decide—firstly, what the *nature* of our requirements is; secondly, what is the *measure* of the necessary modification; and, thirdly, under what *restrictions* must this modification be carried out. The *nature* of our requirements is the maintenance of a certain degree of coolness and purity in the air contained in our rooms so that it may suit the purposes of breathing. The *measure* of the necessary modification of nature's work will be the amount by which it falls short of providing the cool and pure air required in any given instance. The *restrictions* to be observed are threefold—(1) That from the exits provided for the warm air to escape at no downdraughts must proceed; (2) that in admitting fresh air no draught must be produced such as may endanger our health or comfort; and (3) that the air must not be changed so rapidly as to lower the temperature unduly.

Before suggesting various contrivances for effecting these objects, let me say that, as I am treating only of dwelling-houses of moderate dimensions and not of large buildings for public assemblies, it will be unnecessary to speak of steam-fans, of furnaces, of enclosed gas-jets, or even of water-sprays as agents for the removal of warm air. The original cost and current expense of two at least of these methods entirely prevent their use in ordinary dwellings. Of the two others—viz., the enclosed gas-jet and the water-spray—I have no experience, having been inclined to view them too much in the light of an extravagance to make a trial of them. I am therefore left to make the best I can of gravitation and of the wind, two agents which cost nothing, but which may be guided in such a way as to render valuable service

without adding much to the original cost of building a house.

Under this limitation let us consider what we have to do in order to maintain a reasonably pure and cool air in any room. Our aim must be twofold—viz., to remove the warm and vitiated and to introduce cool and pure air. It is very little use to provide for either one of these operations without the other, while the intelligent carrying-out of *both* tends to render the working of *each* more effective. Thus, if the warm air is removed freely it is reasonable to expect that cool air will flow in more readily, and, if the entrance of cool air is facilitated by easy and suitable passages, then the warm air is likely to be withdrawn more readily.

First, then, as to the *removal of warm air*. The restriction imposed upon us in doing this is that we must avoid any arrangement which will allow of a downdraught. Naturally, the removal must be effected at the upper part of the room—the warmest place. Above the top of windows and doors in an unventilated room, especially in one which is artificially lighted, there is a close reservoir of hot and impure air which cannot escape. It is prevented from going upwards because it finds no vent, and it cannot descend because it is lighter than the air below it. No person could long endure it without fainting; its effects are seen upon the bindings of books on high shelves; and I know of nothing for which it is good except, perhaps, for keeping cigars dry. In designing a new house I should endeavour to prevent this accumulation by providing an opening through the ceiling above a perforated centre-flower, because this is at the very highest point and because it is central, and if over a gas-pendant it would prevent the vitiated air from the latter from spreading over the ceiling. After entering the centre-flower the warm air should be conducted by an air-tight passage containing as few bends as possible up to an exhaust ventilator on the roof. The type of head which I prefer to fit on the top of the pipe is a *fixed* exhaust ventilator, such as the Torpedo, or one of Boyle's make. Any form of *revolving* ventilator is less certain than these except in high winds, while a cowl to turn from the wind may fail to do so in a calm, and will sometimes stick fast. It is of no use to discharge the warm air direct into the roof or into the space between two joists, however well provided the roof may be with means of exhaust, or the joist-space with gratings through the walls. In either case you are sure at times to be troubled with a serious downdraught, and are not likely, even occasionally, to find the warm air carried off. In old houses it might in many instances be costly to fit up a tubular arrangement. Where the cost stands in the way the best substitute will be one or two non-return ventilators, such

as the Arnot or Sherringham, fixed into the chimney just below the cornice. These should not be put through the outer wall, because in such a position they are exposed to direct currents of air. I am unable to suggest any other plan that is worth trying, but wish to emphasize the statement already made that, unless some provision has been made for carrying off the warm air, there is very little good in spending money for the purpose of admitting cool air.

Next as to the *admission of pure and cool air:* The restriction under which this must be done is that no draught must be produced. The most urgent demand for air is that made by a fire: it must have a sufficient supply or it will burn dead and emit smoke into the room: if it gets no supply it will go out as soon as it has exhausted that which was contained in the room. As every operation is conducted by nature in the easiest available way, the demand of a fire for air, being made near the floor, is most easily supplied from the space under the doors or French casements. The result is that a draught is created round the feet and ankles of those who are sitting round the fire in the hope of obtaining warmth. A very simple arrangement will prevent this. Through the floor, just inside the rim of a fender which has no bottom plate, let a number of holes be bored into the space between two joists. Nail some perforated zinc or copper over these holes to prevent sparks from entering. Break through the wall between the two joists and fix a large grating in the hole. You will then get a copious supply of fresh air to the fire from openings so placed that the current from them will not pass your feet. But there is another advantage which is not so obvious. It is this: that a fire supplied in this way is more effective in warming the air of a room. Most of the heat derived from an ordinary fireplace is radiated heat—heat which shines out into the room and thus warms the persons, the furniture, and the air which it contains. But I have shown that the air which ordinarily supplies a fire is drawn across the room from points at some distance. It is therefore obvious that the air in front of the fire, which has already received some of the radiated heat, is constantly travelling towards the fire, and passing up the chimney, whilst its place is being supplied by another lot of cold air from the doors, &c. This process acts continuously to curtail the zone of the fire's warming influence. Now look at the contrast presented by the improved method. Under it the fire draws its supply of air from the outside through apertures close at hand and at the floor-level. It does not draw any general current across the room. At the same time, the rays of the fire penetrate and warm, as before, a quantity of air in front of itself, but which is now stationary instead of moving towards it. This air, instead of being sent

to waste up the chimney, rises as soon as it is sufficiently warm, and circulates about the room, to be replaced by cooler air from parts beyond the direct influence of the fire. By this method, then, we have supplied the fire with air without creating a draught, and have at the same time increased its effectiveness as a dispenser of warmth. We may next proceed to cut off its old and objectionable sources of supply by fitting carpet-slips on the floor close up to the underside of the doors or casements. Plate XLVIII., fig. 6, shows a section of the openings for admitting air to the fire.

Having provided for the needs of the fire, we have only to consider those of the gas and of the occupants. If we open a window at the top we get a direct draught across the room or down upon the heads of those sitting; if we open one at the bottom we get a draught across the body or neck. These methods are therefore not admissible. We must arrange to bring air in—(1) at a level at least higher than our heads when we are sitting; and (2) in such a direction as will insure its passing upwards, and not downwards or across the room. If we can do this we shall obtain a pure-air supply with the minimum of risk to health or comfort. There are two ways in which we may do it. The simpler plan in a new house is to make the lower bar of each window-sash 1in. deeper, and then to build up the sill inside 2in. higher than usual. This provides 3in. more than the customary overlap. It will then be possible to lift the lower sash 3in. without leaving a less than ordinary overlap, and therefore without making any opening through which a direct draught could pass across the room. But by this lift we have separated the dividing-bars of the two sashes about 1½in., and in such a way that the air entering at this point must flow upwards, and cannot create a draught downwards or across the room. Plate XLVIII., fig. 7, shows the section of a window-sash and sill so constructed.

In an old house a rough method may be adopted to effect this object. Fit a piece of wood 3in. deep accurately to the lower side of the window-sash and into the recess of the sill. When ventilation is desired lift the sash, place the piece of wood, and shut the sash down upon it. The inconveniences of this plan are that the window cannot be fastened without removing the filling-piece, and that the latter has to be stowed somewhere out of the way.

The other way to admit air satisfactorily is to fit Tobin tubes against the wall, and to supply them with air from the space between two joists. Where it is possible to do so a space should be selected which extends right through the house, and each end should be provided with a grating. The reason for this through passage is that if there is only one

opening into the space a wind blowing directly upon it will produce a strong rush of air up the tube, and very likely a draught in the room, whilst an opposite wind might sometimes check the proper action of gravity. The principle of the action of the Tobin tube is that of a fountain. It provides an entrance for heavy air into a reservoir of light air. The tube, being placed vertically, directs the air, which enters with a slight force, straight upwards, until its greater weight prevails and brings it gently downwards over the room in the form of the spray from a fountain. It descends so gently as not to cause a draught in the room. Plate XLVIII., fig. 8, will explain the general arrangement of one of these tubes.

It now remains to consider the *measure* of the various appliances for removing the warm air and supplying cool. It is not easy to lay down rules which are of general application; but I think it may be safely stated that, where ventilation fails, it is more often owing to the apertures being too small than too large. All that has to be guarded against is the production of draughts and the too rapid lowering of the temperature by admitting the air too fast. This can be readily prevented by closing some of the openings. The provision must depend upon the number of persons likely to occupy a room at one time; upon the consecutive number of hours that it may be used without an opportunity being afforded for a thorough blow-through; upon the amount of gas consumed; and in some cases upon the position of the room in relation to its surroundings. Some writers give rules which it may be useful to apply; but it is beyond the scope of a short paper and beyond the range of my experience to attempt to criticize these or to suggest others. It may, however, afford a basis for discussion if I give a few particulars of appliances which I have recently had fitted up in a new house. I will only give these for the dining-room, which will also be largely used as a general sitting-room by eight to twelve persons. This room measures 20ft. by 16ft., and is 12ft. high. It will probably be fairly illuminated with four gas-burners, and will rarely have six lighted. It has a fireplace, two windows, one door from a passage, and two from adjoining rooms. Within the marble fender there are openings through the floor into the joist-space equal to 54 square inches in area; but this is reduced considerably by the perforated-copper gratings. On the outer wall a 12in. by 6in. grating is placed over the opening into the joist-space. There are two Tobin tubes, measuring 10in. by 2½in. clear inside, with a fine-wire grating at the top, making an inlet of about 50 square inches. They communicate with a joist-space extending right through the house, with a grating on the outer wall at each end, 12in. by 6in. The lower sashes of both windows are fitted so that they can be raised 2½in.,

and then leave an overlap on the sill, to prevent direct draught, of $\frac{3}{4}$in. The meeting-rails of the two sashes are $1\frac{1}{2}$in. deep, so that the $2\frac{1}{2}$in. lift separates them vertically 1in. clear from each other. These two openings are each 3ft. long, and the clear space between the two panes of glass and the edge of each opposite meeting-rail is $\frac{5}{8}$in., giving 45 square inches for air-entrance. The clear lift vertically exceeds this maximum air-space by $\frac{3}{8}$in., and is perhaps not strictly necessary; but it will at least tend to reduce any throttling of the passage, and possibly to the tranquillising of the air which enters when a wind is blowing. For the hot-air exhaust the cone above the centre-flower is 12in. in diameter at the base; a 4in. circular heavy galvanised-iron pipe is soldered into the top of it, and passes upwards into the roof, there being no floor above, and connects, together with a similar pipe from another room, into a 6in. main pipe, on the top of which is fitted a 6in. Torpedo exhaust ventilator. Plate XLIX., fig. 3, shows a section and part elevation of a room fitted with the three kinds of air-inlet, and the one of exhaust, which have been described.

In two houses at Home I found very satisfactory results from an elaborate ventilating gas-pendant, with large argand burner and globe, in performing the threefold duty of admitting fresh air, of carrying away into the chimney the products of its own combustion, and of removing the hot air from the room. These are, however, costly fittings, even at Home, and I prefer admitting the fresh air into the room at a lower point than they did. Of admitting air to the fire in the way described and to the room by Tobin ventilators I had very favourable experience for many years at Home, and can recommend both with absolute confidence as a great addition to comfort, by preventing draughts and by adding to the purity of the air.

In conclusion, I would venture to express the hope that the simple effort made in this paper to familiarise householders with arrangements which are possible, at moderate expense, in the departments of sanitation and ventilation may result, as they certainly have done for a good many years in my own experience, in making some homes more healthy and enjoyable.

Art. LXV.—*The Effect of Current Electricity upon Plant-growth.*

By H. N. McLeod.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

In experiments which have been conducted on this subject great success seems to have been attained with electricity of a high intensity, such as is produced by the common frictional machine. Plants are very good conductors of electricity in this state, as is shown by several experiments. A vegetable joint, when tied to the knob of a Leyden jar, was found to discharge it in less than half the time taken by a metallic point; and when a sprig of a certain shrub was tied to the knob of an electroscope, the leaves were affected at three and a half times the distance that they were when wire points were substituted. A blade of grass will show a luminous point while being withdrawn from the prime conductor of a frictional machine, long after a needle has ceased to glow.

Mr. Pine, of Maidstone, using Leyden jars filled with earth, and keeping one charged with negative and another with positive electricity, found that seeds which were planted in the negatively-electrified jar germinated more rapidly and grew faster than some which were planted in the positively-electrified jar; while seeds which he planted at the same time in an unelectrified jar were two days later in appearing, and did not grow as rapidly.

Monsieur Grandeau, at Nancy, and Monsieur Le Clerc, at Mettray, in France, found atmospheric electricity to have a marked effect on the seed- and flower-producing powers of grain- and tobacco-plants; but opposite results were obtained in the experiments of Monsieur C. Naudin.

A Mr. Weeks applied electrified water to seeds, which appeared above the ground sooner, and grew with much greater vigour, than seeds watered with an equal amount of unelectrified water.

In one of the supplements to the *Scientific American* of some months back this experiment on a large scale was described, and the trial was a decided success.

Vegetables grown under the electric light were found to mature in one-third less time than it took vegetables which were not exposed to the electric light. This was proved at Home, in England, just recently.

The method of applying the electric current in most of the following experiments was by connecting the poles of an

electric cell, or the terminals of a battery composed of a number of cells, to two plates of metal placed in the earth, one on either side of the seeds under experiment. Before a conductor of electricity allows the current to pass, the particles of the conductor assume a forced state, in which they tend to resolve themselves into the elements of which they are composed (Faraday, "Eleventh Series of Researches," pars. 1298 and 1299). For instance, a solution—double cyanide of silver—is taken, and two plates immersed in it. These plates are connected with the poles of a cell; the current leaves one plate and passes through the liquid to the other plate, and resolves the solution into its two elements as it passes. Throughout the whole of the liquid where the current passes, separations and recombinations of the elements take place, finally leaving cyanogen at one plate and silver at the other. This is a simple electrolytical result. In substituting earth for the above solution, secondary results would follow ("Experimental Researches," by Faraday, vol. i., pars. 743, 744, &c.). Thus, if the earth surrounding the roots of a plant is resolved into elements and recombined continuously, it might be supposed that the roots of the plant would absorb the elements it required easily, and so the plant would grow more rapidly.

In one of my first experiments two peas were taken: one was planted in a small iron vessel 4in. in depth and 2½in. in diameter. In this vessel two copper plates, 3in. long by 1in. across, were placed perpendicularly, and with 2in. of earth separating them. Each plate was connected with a pole of a cell, made after Cabaret's plan. The current given by this cell was strong enough to deflect the galvanometer-needle 65°. This galvanometer was formed with seven coils of No. 26 B.W.G. wire wound round a magnetized needle ¾in. in length, and suspended in the same way as ordinary compass-needles. This current from the Cabaret cell was not of great intensity. In a second vessel, similar to the first, another pea was placed at an equal depth of 1in. The soil was taken from the same spot, and so it was of the same quality and moistness in each case. From time to time they were watered with like quantities of rain-water. The vessels were placed side by side at the same distance from the window, and so exposed to the same temperature, and enjoyed the same amount of light. In fourteen days from the time of setting, the seed which was *not* under the influence of electricity came up. Forty-eight hours later seed No. 2 appeared. In twenty-one days, however, this plant had grown to an equal size, and in thirty-five days the seed under the influence of electricity had decidedly outgrown the unelectrified one. The cell was then disconnected, and the copper plates in the ground were connected with each

other. By testing with solution of iodide of potassium and litmus-paper, traces of a passing current were obtained. At the end of further six weeks' time the electrified seed had outgrown the other by one-half.

Experiment No. 2: A glass vessel was taken and filled with soil. In the centre a coil of wire consisting of seven spirals, four of which were stripped of insulation, was placed. A current of electricity, which was interrupted at times, was kept circulating, losing little or no force in the passage. Close to the uncovered wires of the spiral three mustard-seeds were planted so as to be in the range of the electricity induced in the surrounding earth (Ferguson's "Electricity," pars. 248, 249). Three other seeds were planted in the surrounding earth: these seeds were as nearly alike in size as possible, and were about an inch from the spiral. The glass vessel was placed in the open, and so exposed to even conditions of weather. At the end of seven days the seeds were separated from the soil, put end to end, and measured. Those planted near the coil measured $\frac{1}{3}$in. longer than the ones removed from it.

Experiment No. 3: Ten seeds of mustard were taken, and planted each 1in. apart in the garden, in soil mixed with guano. In ten days the seeds were all above ground, some $\frac{1}{3}$in., some $\frac{1}{6}$in. All these were exposed to the same conditions of weather, and were watered equally. As time went on it was noted that the plants preserved their relative size until they reached maturity, save in the case of the two experimented upon. The same was the rule with seeds planted in soil mixed with bone-dust, and in ordinary loam. Two out of the ten seeds were selected, each one-sixth smaller than several which were noted, and equal in size to the rest. The soil in which these two grew was included in the circuit of an electric current which deflected the galvanometer-needle 65° when the earth was not included in the circuit, and scarcely at all when the earth was included. On either side of the plants, in the ground, silver plates, each $\frac{1}{2}$in. by 3in., were placed, and these were connected to the cell by wires. In fourteen days the two mustard-plants had grown equal in size to the larger plants, and in another two weeks had increased more rapidly, and when they reached maturity were one-sixth larger than the largest of the others.

Experiment No. 4: A fourteen-cell battery was connected with two small plates which were put in the ground 1in. apart, a current of electricity was circulated round the roots of two mustard-plants for the space of two weeks, but scarcely any advantageous effect was noted. The anodes in the ground were worn, or, rather, eaten into, very little, which would show that there had been little chemical action,

and consequently the soil was not the best adapted for this experiment.

Experiment No. 5: A glass vessel was taken, about the size of an ordinary tumbler; it was filled with earth to a depth of 2½in.; ¾in. of equal parts of guano and earth was laid on top of the loam. On the top of this layer the mustard-seeds, selected on account of their rapid growth, were put. They were previously soaked in water for forty-eight hours. A layer of guano and loam, in equal parts, was spread over them, and in twenty-eight hours two seeds appeared above the ground. Two silver plates were then placed in the earth, one on each side of one of the seeds. To these plates wires were connected, which conducted an intense current from a battery of fourteen cells arranged in series. When the wires were joined and the circuit complete, the galvanometer-needle was deflected 20°. When the inch of earth was included the needle was deflected 5°. In forty-eight hours more the seed between the plates had grown 1⅜in.—nearly double the growth of the unelectrified one, which was ¾in. From this stage the growth of the seed between the plates, round whose roots the electricity circulated, seemed to be checked. The current of electricity was then reversed, and sent through the earth in the contrary direction. On the fourth day the unelectrified seed caught up to and just outstripped the electrified one. On the fifth day the length of the unelectrified seed was 3¾in., and the other 2½in. high. A third seed had appeared shortly after these two, and it maintained its relative position with the unelectrified seed, being 2¾in. in length after five days. On taking out the plates each was seen to be eaten away—for both were anodes in turn—and about the weight of a threepenny-bit in silver was incorporated with the soil in which the plant was growing. Probably the plant became aware that it was existing on rather hard fare, and so it concluded to stop trying to push ahead. Had there been a vegetable substance as an anode, in place of a silver plate, it is very probable the plant would have increased its first substantial lead. On the whole, favourable results have been obtained, and, if a decomposable vegetable substance can be substituted for the metal plates hitherto used, there seems reason to believe more favourable results will be obtained.

ART. LXVI.—*Notes on some Bone Combs for dressing the Head of a Maori Chief, found in Otago.*

By A. HAMILTON.

[*Read before the Otago Institute, 12th July, 1892.*]

Plate LII. (in Part).

THE natives of the East Coast about Poverty Bay and the Mahia have an ancestor of whom great deeds are recorded, and who figures in several of the curious and interesting traditions which from generation to generation have been passed on, not in a haphazard way, but guarded by all the precautions possible to insure literal correctness. This ancestor was the great and powerful chief Uenuku. According to the genealogies given by several branches of his descendants, he must have lived about the time of the Norman conquest, earning for himself, by his success in intertribal fights and disputes, a name of renown as a chief and authority as a great *tohunga*. Two of his sons, Ruatapu and Paikea, are the heroes of a very interesting tragic poem which was published by Mr. Colenso some years ago, and of which two similar versions from other sources appear in Mr. John White's "History of the Maori." The whole of the trouble arose indirectly over the right of a chief and of the sons of a chief to wear an ornamental comb in the knot of hair drawn up on the top of the head. The hair of a warrior in the piping times of peace was allowed to grow long, and was carefully dressed, and tied up in a neat knot; behind or into this the comb was fastened, and sometimes adorned with feathers, or shreds of the *aute* or *tappa*.

The people of Uenuku's tribe were all busy and excited, for it was a great occasion in the Bay. After much hard work, and after many risks and dangers, a great war-canoe had been brought down to the beach; it had been fitted with the carved work, and ornamented with feathers and red paint; everything was ready for the launch and trial-trip.

"Then it was that Uenuku ordered his sons and the sons of other chiefs to assemble, in order that the hair of their heads might be combed and anointed, and neatly tied up in a knot on the crown, and ornamented with a high dress-comb stuck in behind, so as to be regular and look beautiful, that they might go all together and paddle the new canoe out to sea." Uenuku himself performed this work of preparing and dressing and tying the hair. This ceremony was always performed by a chief of rank or a *tohunga* (Uenuku was both).

This was because the head was pre-eminently sacred, and never to be touched save by a *tapu* person. The young men were seventy in number, all told, and Uenuku finished with Kahutiaterangi. When all was done Ruatapu, another son, called out to his father, "O honoured sir! see! tie up and dress my hair also." His father says, "Where ever shall a dress-comb be found for thy hair?" and tells him that, as his mother was only a slave of inferior birth, he could not on this occasion treat him as the others. This covered Ruatapu with shame, and his whole heart was filled with grief and pain, and, loudly lamenting, he went away to the place where the canoe was, and plotted how to destroy Paikea his brother and those young chiefs who had witnessed his discomfiture.

This he did by upsetting the canoe when out at sea; but the plot somewhat miscarried, as Ruatapu was himself drowned, with the whole of the crew excepting Paikea, who by the power of his spells saved himself after floating about for a day and a night.

I quote this story simply for the purpose of showing by what I take to be a typical example that the comb for the head of a warrior was a very ancient and important ornament.

Coming down from the mists of antiquity to the earliest voyagers, we find in Cook's Voyages and Parkinson's Journal several examples of head-combs, drawn by a careful and competent observer, showing that in the districts visited by Cook the dress-comb was still in use, and that a general type form prevailed.

In Forster's account of Cook's voyage he mentions that when they arrived in Queen Charlotte Sound, in June, 1773, several Maoris came on board. Their hair was dressed in the fashion of the country, tied on the crown, greased, and stuck with white feathers, and several of them had large combs of some cetaceous animal's bone, stuck upright just behind the bunch of hair on the head.* In Parkinson's book we find a drawing of a fully-dressed New Zealand warrior,† with a comb of the same pattern as the large one figured on Plate LII., and on plate xvi. of the Journal another. The description on page 90 says, "Most of them had their hair tied up upon the crown of their head in a knot, and by the knot stuck a comb of wood or bone." Other examples of this kind of comb are shown on plates xix. and xxiii. of the Journal.

Mr. Colenso, in his essay on the Maori race,‡ says, "Their combs for their hair were also both neatly made and carved: these, however, were not used as combs commonly are by us,

* Vol. i., p. 126. † Pl. xv. ‡ Trans. N.Z. Inst., vol. i., p. 355.

but by the chiefs to keep up their hair, much as English ladies use their high back-combs. The men wore their hair long, and dressed it up with a knot on the top of their heads; the women wore it cut short."

The condition of the Maori nation at the time of the visits of the early voyagers must have been somewhat similar to that of the English people in feudal times, when the life of every gentleman was devoted to fighting, and might was practically right, modified by custom; and in both instances the influence of the priest or *tohunga* was paramount, through the superstition of the masses. We might also say that natural selection on the same lines produced the flower of chivalry of England and the noble savage of many a valiant fight embalmed in the traditions of the Maori race. Barbarities can doubtless be adduced on both sides, but it seems clear that as long as man met man with fairly-equal weapons, hand to hand and foot to foot, the true spirit of chivalry was not wanting; but as soon as that deadly invention, gunpowder, came into use, both knight and chief rapidly lost their mana or reputation for doughty deeds, and consequently were unable either to enforce the discipline or control they once had over their followers, or to protect them from petty aggressions. To the breaking-down of the position and the mana of the chiefs must be attributed much of the trouble which has come upon the Maori nation, and the disorganization of the polity of the nation, leading with a startling rapidity to the abandonment of many old customs and practices, and the hasty substitution of others of questionable superiority.

Amongst the ornaments and insignia of a chief disused for many years we must place the ornamented head-comb. Very few specimens of the real old form are to be found in any of the museums. It is therefore with great pleasure that I have written this short note on the specimens exhibited, which are part of the magnificent collection of Mr. John White, of Dunedin. These specimens have been dug out of the remains of old Maori settlements a little to the north of the Otago Heads. They are made from the thin portion of the lower jaw of various species of whale, which were frequently stranded on the beaches in the olden time, before the advent of the whalers. The specimens bear unmistakable marks of having been made with the ordinary sharp stone cutters (obsidian and quartzite), and rubbed down with grinding- and polishing-stones of different qualities. The size and number of the teeth vary very much (from three to twenty-five), according to the taste or skill of the maker. Those with the coarser teeth are usually the best preserved. The persistence of the type form is very interesting, especially as it practically coincides with those drawn by Parkinson from the North.

In the North Island I have collected fragments of smaller bone combs, having only three teeth, with the top part variously ornamented; and Mr. T. W. Kirk has described a large bone comb with three teeth, found by him near Wellington. The great size of this must have rendered it somewhat an uncomfortable ornament, unless there was a great profusion of hair.

Besides the dress-comb of bone there is another form, more frequently to be seen in collections. It is made very neatly and ingeniously from small slips of hard pine-wood (rimu), pointed, and laced together with delicately-worked lashings of fine flax in various patterns; the two outside pieces of wood being generally carved or ornamented. The shape of this varies: in some cases the head is the wider part, in others the points. These resemble in construction and form combs from many of the Pacific islands. It would be an interesting study to collate the various forms of combs used in the different groups, noting where the use is limited to chiefs, &c.

The usual term for the head-comb is *heru* or *karau*, the latter being also used for the dredge or rake used for obtaining fresh-water unios or pipis from the bottom of a lake.

It is unnecessary, perhaps, to state that, besides being ornamental, the combs were useful for practical purposes.

A figure of a wooden comb, which was found in one of the Sumner caves, is given in plate ii. of volume xxii. of the Transactions of the N.Z. Institute.

DESCRIPTION OF PLATE LII. (in Part).

Nos. 1, 2, 3, 4, 5. Bone combs dug up at Murdering Beach, near Dunedin, now in the collection of Mr. John White, Anderson's Bay.

6. Head of a bone comb found at Cape Kidnappers. A. Hamilton.

7. Bone comb in collection of Mr. S. Drew, of Wanganui. Several small holes are bored in the teeth of this specimen. They do not appear to have any use or significance.

Art. LXVII.—*Notes on some Old Flax Mats found in Otago.*

By A. Hamilton.

[*Read before the Otago Institute, 11th October, 1892.*]

Plate LII. (in Part).

I. Nothing has been written yet concerning the textile fabrics of the early inhabitants of New Zealand which gives any details of the structure of the numerous mats and useful articles woven by the natives in the industrious times of long ago.

Do not let me raise a false hope—I cannot worthily describe the whole details of so great an undertaking, but I wish to place on record a few particulars of some extremely old specimens of weaving found in the cave-shelters of central Otago.

The first formed a portion of the wrappings around a skeleton found in one of the burial-caves or rock-shelters in the Strath-Taieri, on the property of Mr. William Bennett. It is but a small fragment of a coarse woven mat of partly-dressed flax, resembling very coarse cocoanut matting. The dressing of the flax being very incomplete, the golden hue of the surface of the dried flax-leaf still appears in some of the thicker shreds. The warp is very thick (9mm.), and roughly plaited or intertwined with stiff white feathers (of a bird which I am not yet able to identify). Just enough of the shaft of the feather is twisted in to hold it firmly; the rest of the feather sticks out at different angles. In some of the strands, feathers of a brown weka (*Ocydromus*) are included. The woof which binds the coarse warp together is 2½mm. in diameter, and the knot used is very curious (see fig. 1, Pl. LII.). Time and insects have destroyed many of the feathers, leaving only, in some parts, a fine down of a grey colour. Together with this venerable fabric was an inner wrapper made of the skins of *Ocydromus* sewn together. The skins were well prepared and dressed, being probably rubbed with wood-ashes, and were still covered in part with feathers of a dark variety of the weka (*Ocydromus*). In the bare part the pterylosis showed plainly, and, with the small apertures through which the tiny wings had been removed, completed the identification. The edges of these skins—five in number—were folded down about an eighth of an inch, and oversewn with thin twisted flax twine from the back. Over one of these seams on the front I found a narrow strip of skin, placed apparently to cover the join, very much decayed, 3in. long by ¼in. wide, but still carrying a dark-grey down, and five or six double-shafted feathers of the moa. They were much moth-eaten, and became detached from the skin during examination. The fragment is certainly somewhat microscopical, yet it has a great interest in being, so far as I am aware, the only piece of moa-skin yet recognised as occurring on a mat or covering. The fragments of these wrappers, and the feathers, are in the collection of Dr. Hocken, and I am indebted to this gentleman for the opportunity of examining the find.

II. Another flax mat from the same district has been for some years in the Otago Museum; and, as I found on examination that it is of unusual construction, I now give a brief description of it. The general appearance is not very different from that of a good *kaitaka* flax mat from the North

Island, the warp-strands being close together—about seven to the inch—and the woof-cables at about the usual distance. The method of working the woof is shown on Plate LII., fig. 2. Now, the most valued robes of the Maori in olden time were adorned with narrow strips of the skin of the dog with the hair attached. The strips on the borders of the mat were fastened at one end or at the middle, and hung loosely, forming a handsome fringe; those on the body of the mat were placed along a warp-strand, and were fastened down by the woof-cables, and kept in position.

In the mat under notice the upper and lower edges had had a fringe of strips of dogskin, with black, reddish-brown, and white hairs, twisted in; but the body of the mat was covered with thin carefully-cut strips, 4in., 5in., or 6in. long, of birdskins. Little indication was left of the plumage on these dried and perished strips, but Dr. Parker, the Curator of the Otago Museum, after a careful microscopical examination, pronounces the strips that he examined to have been cut from the skin of the green parroquet (*Platycercus*).

To give an idea of the amount of work requisite to complete this cloak (the fragment which remains measures 4ft. by 5ft.), I counted the number of strips of skin in a part where they are still pretty perfect, and I find that in 2½in. (65mm.) there are nine parallel strips of birdskin, with eight warp-threads showing between the strips, and so well put in that they appear to run continuously from the top to the bottom of the mat. There are no "bias" seams visible: these are invariably found in more modern mats, and are intended to shape it to fit the shoulders more comfortably.

The other details of structure are less important, and are probably individual peculiarities. Sewn on to the upper portion of this mat, at a place where it was much worn, was a very thick and warm flax mat, quite plain, evidently for additional warmth to the shoulders.

If the whole of this mat was covered with the green feathers of the parroquet it must have been a very beautiful object, and rivalling the feather mantles of the Hawaiians and Peruvians. I think it probable, however, that other birds may have been used, as the thickness of the strips of skin seems to vary.

ART. LXVIII.—*On Two Bone Pendants found in the South Island of New Zealand.*

By A. HAMILTON.

[*Read before the Otago Institute, 12th July, 1892.*]

Plate LIII.

AT the mouth of the Shag River, on the east coast of Otago, are the remains of middens or refuse-heaps of great size, and probably of great age. The contents of these middens have been partly described in papers laid before the Institute,* and a general idea of their contents given. The ridge of sandhills stretching northward across the mouth of the valley was formerly covered by the dwellings of those who have from time to time lived at this spot. Now, the wind shifting the sand from place to place often exposes the long-buried relics of the vanished race. Mr. James Meredith, of Palmerston, one day picked up on these sandhills the piece of carved bone shown in Plate LIII., fig. 1, and since then it has passed into my collection. The ornamental character of the relic is at once apparent, and it is also evident that great skill, as well as labour and patience, was required to carve it from the solid and dense whale's bone of which it is made. The extreme length is 130mm.; the width at the top, without the ornamental border, 28mm.; width at the centre, including the borders, 40mm.; the thickness, including the ornamental ridge, is 14mm.; the height of the central ridge, 5mm.

The base of the thin ornamental ridge in the centre shows that the ridge was first worked down to the proper thickness, and that then the cut-out portion was started by boring small regular holes from the right side of the object to the left. They do not appear to have been drilled from both sides as usual, probably on account of the thinness of the piece to be cut. The centre ridge and the side ridges, or borders, were finely notched or crenulated on the outside edges.

Enough of the side-borders remains to show that they extended down the whole of each side to the pointed lower end, which takes a sharp turn upwards, much increasing the difficulty of manufacture. The lower part shows signs of wear, and the polished condition of some of the lower fractures indicates that these had occurred before the object was lost or

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* Trans. N.Z. Inst., vol. iv., p. 66 (Von Haast). Trans. N.Z. Inst., vol. viii., p. 103 (Hutton).

buried. A well-drilled hole at the top enables this beautiful pendant to be suspended.

The centre ridge commences 11mm. from the top edge, just giving room for the hole for suspension.

The character of this pendant is so different from those generally used as ornaments by the Maoris that I might have hesitated to bring it forward if I had not been able, through the kindness of the Director of the Colonial Museum, to accompany it with a figure of a pendant (Pl. LIII., fig. 2) almost exactly similar found by Mr. Robson near Cape Campbell, and sketched by me, as an illustration to Mr. Robson's paper, in the Trans. N.Z. Inst., vol. ix., pl. vi., p. 280.

This specimen is 88mm. long, and about 20mm. in width. The pattern cut is exactly the same, but the work is a little more rounded than in the larger example, and there is no central ridge, nor any denticulation of the edges.

There is the same upward curving of the narrowed lower part, and the hole at the upper end for suspension. There is a slight groove or depression in the centre, near the top, at the widest part.

The curious curve of the lower end suggests at once a comparison with the stone pendant figured by the late Mr. John White in Vol. iii. of the "Ancient History of the Maori," p. 192. This has a triangular section, and the front angle has on it a number of notches, which, Mr. White states, were marks for genealogical purposes, and used in the same way as the *whakapapas* or carved staves. I have given an outline-figure of this pendant (Plate LIII., fig. 3), with sections (figs. 7 and 8), from a cast of the original. It will be seen by section *b*, fig. 8, that the upcurved point is strongly channelled, like a gouge. I also notice very evident knobs or horns on the head of the face at the top. It is interesting to note that, although this form of pendant is evidently very rare and of a peculiar style of art, it is exactly matched by a fragment picked up by Captain G. Mair near Cape Kidnappers, in Hawke's Bay (fig. 4). I do not know of what material the one figured by Mr. White is made, but the Kidnappers specimen was of a very hard white-and-red porphyritic stone.

It is difficult to suggest an explanation of the actual meaning of the shape of these pendants; we may, however, be sure that there originally was a deep significance in their strange forms. Comparisons may be made with the long greenstone eardrop, sharply curved at the base, common in the North Island but not seen in the South, and with the *palaoa* or curved ornament worn on the breast in some of the Pacific islands. It is impossible not to notice the resemblance between the bone pendants and the sacrum of a bird. We are told that the sacrum derived its name from being the part of

the victim devoted to the gods in a sacrifice. May not these objects be a flicker of some old superstition which has been preserved in this idealised form?

Moseley, in his book, "Notes of a Naturalist on the 'Challenger,'" p. 504, figures one of the hook-shaped ornaments worn by the Hawaiians, which has, however, little actual resemblance to our specimens. Cook, in his Third Voyage, vol. ii., p. 232, says, "The Hawaiians fix [on their necklaces] a small bit of wood, or stone, or shell, about 2in. long, with a broad hook turning forwards at its lowest part, well polished." Captain King, in the same work, vol. iii., p. 135, says, "Both sexes wear necklaces . . . and an ornament in the form of the handle of a cup, about 2in. long and ½in. broad, made of wood, stone, or ivory, finely polished, which is hung about the neck by fine threads of twisted hair, doubled sometimes a hundredfold. Instead of this ornament, some of them wore on their breast a small human figure made of bone, suspended in the same manner."

EXPLANATION OF PLATE LIII.

Fig. 1. Carved bone pendant found at Shag Point, Otago.
Fig. 2. Carved bone pendant found near Cape Campbell (Colonial Museum).
Fig. 3. Side view of stone pendant figured in "Ancient History of the Maori," vol. iii., p. 192.
Fig. 4. Fragment of similar stone pendant found at Matarau, near Cape Kidnappers, Hawke's Bay, by Captain Mair (from a rough cast).
Fig. 5. Side-view of No. 1: full size.
Fig. 6. Side-view of No. 2.
Fig. 7. Section of No. 3 at *a*.
Fig. 8. Section of No. 3 at *b*.
Fig. 9. Section across the middle of No. 1.
Fig. 10. Section across the middle of No. 2.

ART. LXIX.—*Notes on Maori Necklaces.*

By A. HAMILTON.

[*Read before the Otago Institute, 11th October, 1892.*]

THE Maoris, as seen by Captain Cook, the early voyagers, and missionaries, were not much in the habit of wearing elaborate necklaces; and we have no evidence of their caring for the beads and gewgaws which usually formed part of the trade-goods of the pioneers of civilisation. Hoop-iron and axes and weapons of a practical kind were the objects most in

demand. Certainly, the wearing of an amulet or pendant, or sachet of sweet-scented gums, was constant and almost universal among both sexes; but the necklace of the northern continental areas, composed of beads, or perforated stones more or less elaborately shaped, was virtually unknown, and—which is rather strange—did not come into fashion with the adoption of European customs and habits. Even among the prehistoric races in Europe and America elaborate necklaces are usually found with human remains. This seems to have no parallel among the Maori people. The few specimens of old blue-glass beads, some quite plain, others facetted, which have been found sparingly in Maori camps and pas in the North and South Islands, are no doubt part of the trade-goods of the earlier whalers, and were probably worn, a few together, as an ear-ornament.

In the middens and remains of villages in the southern part of the South Island are found relics which prove an exception to the rule, and are of considerable interest. In the collection of relics found by Mr. W. Mitchell in the neighbourhood of Lake Manapouri, there is a necklace nearly 2 yards long composed of the shells of a small dentalium, or tusk-shell. The shells composing it were found lying together, and amongst them a greenstone ornament, shaped like a conventional hook called a *matau*. Mr. John White, of Dunedin, has also a similar necklace in his collection.

In the encampment at the mouth of the Shag River, near Palmerston, I have dug out from the middens a number of the large fossil shells, *Dentalium giganteum*, brought there from the Waitaki, from which short cylinders were cut, and probably strung together for necklaces or ornaments.

In at least four collections in Otago there are numbers of miniature axes about 1in. in length, made from a piece of a marine shell, ground to the shape of a stone axe, and pierced at the other end for suspension, not at right angles to the part corresponding to the edge, but in the same line with it. In one instance over a hundred of these, much burnt, were found in the ashes of an old house, all in a heap. Mr. F. R. Chapman exhibited a considerable number amongst his splendid collection of bone objects at the Dunedin Exhibition of 1890, and called attention in his catalogue to the curious instance given by Professor Boyd Dawkins, of the Bosnian peasants wearing necklaces of cornelian arrow-heads even at the present day. Mr. Chapman says in a note,* "May not these ornaments be looked upon as a survival from an ancient epoch, when the Maoris dwelt on an island in the Pacific where no stones for axes were procurable?"

* Official Cat. N.Z. and S.S. Exhib., 1889–90, p. 172.

Altogether I must have seen about two or three hundred of these little shell axes, all of which are about the same size. Mr. T. W. Kirk (Trans. N.Z. Inst., xi., 539) notes the occurrence of bones cut in adze form.

I have another illustration. In a notice of a jet necklace discovered in a burial-mound* or tumulus in north Wiltshire, England, it is stated that one of the beads was in the form of a small stone axe of a short-triangular shape, "showing that the Britons sometimes made beads of this material (jet) resembling stone implements in miniature, just as the Scandinavians did in amber."† It is perhaps somewhat premature at present to insist on the matter, but I am of the opinion that these interesting relics will be found to have belonged to the autochthonic race or races of the South Island, and not to the later Maoris. There are many facts which support this view, the discussion of which must be left till another opportunity.

There are three other kinds of ornaments which we know were often worn in the ear, and which, in some cases at least, appear to have been worn in numbers round the neck—the one being human teeth, another the canines of dogs and seals, and the third the flat triangular teeth of the great blue shark, not the beautiful curved teeth of the mako of the North. These triangular teeth are frequently found with a neat hole bored at each of the basal angles, and sometimes with a third larger one in the middle of the base. At Warrington I found one of these teeth with both of the basal angles cut off, and one hole through the centre of the base. In some cases it is possible that these teeth may have belonged to the formidable wooden knives, set with sharks' teeth on each edge, occasionally seen in the early days. The specimens that I have seen had, however, the teeth of the Perlon shark (*Notidanus*).

NOTE.—Since this paper was read, I am informed by Mr. Chapman that an old Maori has recently seen the "shell axes," and immediately recognised them as *niho kakere*, or shell teeth, and stated that they were worn as necklaces by women. On examining again the few specimens I myself possess, I find the distinction between the part bedded in the jaw and gum and the part exposed is slightly indicated.

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* Archæologia, vol. xliii., p. 510, fig. 200.

† See also Nilsson, Stone Age, Engl. ed., p. 82, pl. ix., fig. 190; Worsaae, Afbildninger, p. 15, figs. 65, 67; Madsen, Afbildninger, Fr. ed., Antiq. Préhistorique, pl. xv., xvi., fig. 19.

Art. LXX.—*Discovery of Maori Implements at Takaka, Nelson.*

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 28th March, 1892.*]

Plate LIV.

During my recent trip to the Takaka district I camped for one night near Rangihaieta, or Black's Point. I had previously been told that the natives had a legend that at this spot, before the advent of the pakeha, there had been a massacre of their race by an invasion from the North Island. I was further informed that there was not the least likelihood of making any discovery of native relics, as the place had been thoroughly searched again and again.

Mr. Bryant and myself arrived on the spot late in the afternoon, and as soon as the camp had been pitched, &c., I started to reconnoitre, as the shades of evening were fast falling, and I wished for a clear, definite programme for an earlier morning start.

After ascending the headland, and taking a hasty survey of the surroundings, and as I turned to retrace my steps, I endeavoured to picture to myself the probable line of attack and retreat, &c. As if by an inspiration I seemed at a glance to comprehend the whole scene; and, further, in the event of a wounded chief fleeing for his life, one spot appeared the most likely for him to endeavour to reach, and there I argued he would be most probable to hide his *axes* or any other articles he valued. In the twilight I went straight to the spot (a group of limestone rocks). When near, I found there were several holes and cavities in them, some filled with stones. My mind was concentrated upon one of these; and after removing the loose stones, at a distance of about 18in. I could distinctly feel the end of a stone axe. After some trouble I removed it, and then, digging into the soil with my fingers, I unearthed two bone points for spears (Pl. LIV.). On the following morning, after five or six hours' fruitless search all around the headland, I completed the search in this same cavity, and unearthed another axe of very hard stone, 4¾in. by 2½in., a thin greenstone axe with a hole drilled in it, a bone implement which I take to be some kind of whistle, and which Professor Hutton states is made from the human radius, a small piece of white quartz-crystal, some pipi shells (*Mesodesma novæ-zealandiæ*), and vertebræ and jaw-bones of barracouta (*Thyrsites atun*).

The depth of the cavity was a full arm's length, and from the solid nature of the accumulated soil I should suppose these implements must have been deposited where I found them at least eighty to a hundred years, and perhaps far longer.

The strange part appears to be the remarkable way in which I was led, as if by intuition, to where they were found, more especially when the next morning a laborious search of five or six hours resulted in not a single trace of anything else being discovered.

Art. LXXI.—*Observations on Mr. T. White's Paper "On the Native Dog of New Zealand"—Transactions of the New Zealand Institute, Vol. xxiv., Art. 51.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

Every kind of evidence is made to tell by writers who have a theory to defend. Max Müller: "The Gifford Lectures," 1891, p. 428.

As headstrong as an *allegory* on the banks of the Nile.
(Mrs. Malaprop.) Sheridan: "The Rivals."

I regret to see a long paper by Mr. Taylor White in the last volume (xxiv.) of Transactions of the New Zealand Institute, ostensibly on the native dog of New Zealand; but, as far as concerns the genuine native dog of New Zealand, it is full of error. And as he has mentioned my name in his paper, and so some of his correspondents (though scarcely fairly), I feel constrained to write a little more additional on that subject. Moreover, I am the more inclined to do this through having very recently obtained some further valuable authentic information on the ancient and long-extinct New Zealand dog. Not, however, that any such was wanted by the seeker after real facts to complete what we already knew concerning it.

Mr. White's paper is pretty nearly wholly a compilation, and that from newspapers and correspondents—men of to-day. Much, however, of what they have written is correct (and I could furnish similar statements long known to me, from *before* this country became a colony, respecting both wild and tame *imported* dogs in New Zealand), but it has nothing whatever to do with the subject in question. Had Mr. White really cared to know the truth—the indisputable and genuine

historical *facts*—concerning the ancient New Zealand dog he would have followed the intimation I had volunteered to give him concerning it in a letter I wrote to him in December, 1890, in reply to his inquiry.* For had he done so I venture to think he would not have written another paper on that subject. Of course, in my so saying, I suppose he had *not* seen my paper on the New Zealand dog, therein so exhaustively brought forward by me; if he had, however, done so, then he seems to have wilfully ignored all the certain knowledge concerning it, in his redundant zeal to establish a "fad" of his own.

Professor Max Müller very justly and eloquently observes in his late lectures at Glasgow (which is highly applicable here), "What is of immense importance in all scientific discussions is the spirit of truth. To make light of a fact that has been established, to ignore intentionally an argument which we cannot refute, to throw out guesses which we know we cannot prove—nay, which we do not even attempt to prove —is simply wrong, and poisons the air in which true science can breathe and live." ("The Gifford Lectures," 1891, p. 81.)

And, as I happen to have taken a copy of my note to Mr. White (referred to above), I give it here verbatim, from which it will be seen how I had put him on his guard, as well as kindly indicated the right direction:—

"Napier, 25th December, 1890.

"MR. TAYLOR WHITE: Dear Sir,—Your note of the 18th instant reached me here just as I had returned from Dannevirke, where I had been some time sojourning. Writing, as you remark, at this time, I would reciprocate your kind wishes, and sincerely wish you all the compliments of the season.

"*Re* your inquiry as to the meaning of the Maori word '*mokokuri*,' I have but little to say (in a note). It means an inferior, or commoner, or coarser, or less-elaborate kind of face-tattoo. *Kuri* is added adjectively to several words in Maori, generally meaning as above (having nothing to do with the *kuri* = dog)—much, indeed, like our English use of the term 'horse'—as in horse-chestnut, horse-mint, horse-mussel, horse-mackerel, horse-laugh, &c.

"From your note I gather you are going to write *again* on the Maori dog. I fear I shall run the risk of displeasing you in saying, 'Think twice before you do so,' or you will greatly err. At all events, *first* read my exhaustive paper on that subject in vol. x., Transactions New Zealand Institute.

* He copies, indeed, a small portion of my note, on an entirely different subject (paper, p. 542).

"Sir G. Grey and Dr. (now Sir James) Hector made, years ago, similar mistakes as I believe you have done.

"I hope you are keeping well. I am not very well just now, and so am solitary at home; and thus writing *this night* to you to be in time for your mail leaving here on 29th. I expect to leave again for the bush about the 10th of January. —Yours, &c., "W. Colenso."

I have lately received a copy of a recently-published English edition of "Crozet's Voyage to Tasmania," by H. Ling Routh, which also contains his voyage to New Zealand. It was in this very early visit of the French ships of discovery to this country, in 1771 (directly after that of Cook), that the commander of that expedition (M. Marion du Fresne) was killed, with many of his men, by the New-Zealanders. The French, however, had dwelt with the Maoris for more than a month in amity, and had seen very much of their manners and customs, their arts and manufactures, their food, and the general natural history of the country, all which is clearly and plainly related. And, among other interesting things, Crozet thus writes concerning their native dog:—

"The only quadrupeds I saw in this country were dogs and rats. The dogs are a sort of domesticated fox, quite black or white, very low on the legs, straight ears, thick tail, long body, full jaws but more pointed than that of the fox, and uttering the same cry; they do not bark like our dogs. These animals are only fed on fish, and it appears that the savages only raise them for food. Some were taken on board our vessels, but it was impossible to domesticate them like our dogs—they were always treacherous, and bit us frequently. They would have been dangerous to keep where poultry was raised or had to be protected—they would destroy them just like true foxes. They have absolutely no other domestic animal than the dog." (P. 76.)

And this statement is the more valuable as it concerns the dog of the Bay of Islands, in the North; while those others, quoted by me in my former paper, observed by Cook and his scientific companions, were from Tolaga Bay on the east coast, and from Queen Charlotte Sound in the Middle Island—all alike tending to show there was but *one* race or breed. Mr. White indeed says, "There is no reason why the Maori should not have possessed dogs of different breeds and of various shape and size." (Paper, p. 550.) Which, after his fashion, he supports by noticing the many lately-introduced varieties of dog among them at this day.

One of Mr. White's correspondents—Mr. Skinner, of New Plymouth—in his long letters respecting a dogskin mat (paper, *l.c.*, p. 544), in which he argues from its reputed

Maori age, and from the time in which it was made (also on Maori testimony), that it must therefore have been that of the indigenous Maori dog, further says, "This part of New Zealand—Cape Egmont—was quite unvisited by the very early whalers and traders up to about the years 1825 to 1830, and only then very occasionally, so there can by no possibility be any chance of these skins being crossed with the European dog; and I have yet to learn that the very early traders brought dogs with them as an article of trade." (Paper, p. 545.)

To meet this (or, rather, these two statements), I quote the following from Dr. Marshall's New Zealand:*—

"Examination of Mr. John Guard, master of the barque 'Harriet,' before the Executive Council, New South Wales, 22nd August, 1834:—

"In proceeding from Port Jackson to Cloudy Bay, New Zealand, the 'Harriet' was wrecked on the 29th April last, near Cape Egmont, on the Northern Island. The crew, consisting of twenty-eight men, all escaped on shore, as also one woman and two children. About thirty or forty natives came the third day after we were wrecked. We had made tents on shore of our sails. . . . On the 7th May about two hundred more natives came down . . . . They did nothing that day, but on the following day they came all naked, and *at least a hundred and fifty with muskets,* and the rest with *tomahawks* and spears. . . . The tribes there could not raise above three hundred men in the whole, and *about two hundred muskets.* . . . I have been trading with the New-Zealanders since 1823, and have lived a great deal amongst them. . . . One of the crew, who had been trading with the New-Zealanders for nearly six years, and had lived on shore about thirty or forty miles from whence these natives came, understood their language perfectly; I also understood it partly myself." (*L.c.*, pp. 344–348.)

And, again, Dr. Marshall says (after a stay there of more than a fortnight), "The openness of the coast, the violence and frequency of an impassable surf along its shores, rendering any supply of fresh fish contingent upon the winds and weather, and, consequently, very precarious, while the absence of native animals, and the paucity of those *imported,* such as dogs and pigs, occasion a dearth of flesh-meat, and force the people to feed chiefly upon vegetable diet. . . . The dog, from the treble purpose served by it, of a watch

* Dr. Marshall's narrative of his two visits to New Zealand, as surgeon in H.M.S. "Alligator," in 1834, is very interesting. His book was published in London in 1836. I knew him personally: he was a truly honourable man, and a good Christian.

when living, and food and clothing when dead, is highly valued by those it serves, and its bones carefully preserved. The skeleton of one, bleaching in the sun, was found on a high pole at the Namu [name of one of the captured pas], with the *tapu*, or sacred thread, wound round it, and a tuft of white feathers fastened to its skull." (*L.c.*, pp. 215, 216.) Of course Dr. Marshall received this information respecting their food, and much more, from Mrs. Guard, who with her child were residing as captives among those Maoris for five months, until they were rescued by H.M.S. "Alligator," and who were most honourably and carefully treated by them. (I knew this Captain Guard well; indeed, we were fellow-passengers during a protracted voyage in a small craft from Sydney to the Bay of Islands in 1834.)

And here I would briefly mention another sad time in Maori history, anterior to the wreck of Guard's ship (as bearing on the matter in question)—viz., the long devastating war carried on in those parts by the Waikato tribes against the Ngatiawa, the resident tribe, and particularly the bloody sieges of two principal pas there—Pukerangiora and Moturoa. Now, the Moturoa Pa was strongly fortified, and the Ngatiawa within it were much helped by the well-known resident trader Richard Barrett and his European men—about a dozen in all. These Maoris were also *well armed*, as Barrett had been long supplying them with muskets, ammunition, &c.; while the whites had also two ship's cannon, which they used successfully against the besiegers.

So that from these facts—of those Maoris being at that early date so well supplied with European arms and ammunition—the reasonable inference is that there must have been a considerable *trade* by way of barter long going on between them and shipping.

I can assure Mr. Skinner that "the very early traders did bring dogs with them as an article of trade," and large-sized ones too; these being particularly sought after by the Maoris for their skin. Such were seen by Marsden and Nicholas on their visit to and travels in New Zealand in 1814–15, and "in large numbers," too, and "running wild."* And such (apart from my own certain knowledge) is, moreover, highly reasonable, as without them the Maoris could not have caught the wild pigs which were a chief article of barter with those traders and early whalers—indeed, the only animal food of the country that they could use or obtain.

Moreover, the facts stated by Dr. Marshall—(1) of the bones of those "imported" dogs being "carefully preserved"; and (2) the skeleton of another found "set apart (*tapu*=sacred),

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* Trans. N.Z. Inst., vol. x., p. 137.

bleaching in the sun, and ornamented with white feathers fastened to its skull"—are, to me, a convincing proof that such bones were not obtained from the common small New Zealand dog whose flesh had been used for food (which never could become *tapu* with the Maori), but only from some peculiar and prized animal, such as an imported and high-priced and highly-valued one would be.

Mr. White and his many helpers would have escaped their erroneous statements, inferences, and suppositions had they only steadily borne in mind that the indigenous New Zealand dog was a *purely domestic animal, and never wild.* They might just as reasonably have written of wild dogs or wild sheep in England at the present day.

Mr. Skinner also says, "I am surprised that Mr. Colenso takes up the line that the native dog was a small, miserable cur. From conversations held with intelligent natives I gather that the old Maori dog was by no means a small animal, but a very fine animal indeed, and good-looking withal." And further on he says (writing of one of the dogskin mats), "This is the skin of a very large dog—length 3ft. 8in., by 1ft. 6in." (Paper, pp. 544, 546.)

The very Maori name of the skin mat (or mats) given by Mr. Skinner helps also to confirm its modern origin—*hurukuri* = dog's hair or skin. For a dogskin mat made from the indigenous Maori dog would not have been *so* termed; each kind (and there were several sorts—patterns, I may call them) being known by its own special name, just as in their flax mats. I have seen many such brown dogskin mats, and have also seen them manufactured, in A.D. 1835–37, which I have also recorded in some of my early papers.

Captain Good, another of Mr. White's correspondents, also says (in his letter quoted in Mr. White's paper), "With respect to Mr. Colenso's theory of the native dog, I think he must be in error." (Paper, p. 551.) I am not aware of having propounded any "theory" concerning it—because I have none, never had any. All that I did (in my paper) was to show what the ancient native dog really was, from the united testimony of reliable scientific European witnesses, who had often seen it, and that, too, in large numbers, in various parts of New Zealand, and at different times, and who also wrote its description, &c., at the time. Such evidence of facts is unexceptionable, and with me irresistible.

I did, however, put into my paper a brief *résumé* of the New Zealand dog, drawn up entirely from their descriptions of it, which I here copy; as many who may hear and read this may not have the same opportunity as Captain Good had of reading that paper, written fifteen years ago; and such will further show how widely different in every respect the New

Zealand dog really was from these of Messrs. White and Co.:—

"It appears, therefore, from the united testimony of the first visitors to this country, that the ancient New Zealand dog was much like those of Tahiti and other South Sea isles—that it was merely a domestic animal, small in size, with pointed nose, prick ears, and very little eyes; that it was dull, stupid, and ugly; that it was of various colours—white, black, brown, and parti-coloured—with lank long hair, and a short bushy tail; that it was fed on fish and refuse offal, and that it was quiet, lazy, and sullen, had little or no scent, and had no proper bark." ("On the Ancient Dog of the New-Zealanders," Trans. N.Z. Inst., vol. x., p. 146.)

It was Darwin, I believe, who remarked very truly "that the effects of false inferences are but of little moment, for every one feels a pleasure in setting them straight; but that false facts are most dangerous, because there may be but few who can point out their untruth."*

And Dr. Marshall also has similar remarks at the close of his narrative; which, being made much earlier, and with sole reference to New Zealand matters, I quote here: "In the preceding narrative I have endeavoured to relate events in the exact order of their occurrence, leaving facts to speak for themselves, and principally solicitous of putting true facts on record. For all facts are not true, seeing that some things are said to be facts that never had an existence at all, except in the imagination of the narrator or in the credulity of the retailer. And some facts are so stated as to be what Dr. Cullen calls false facts, either by the omission of something that happened, which if added would alter their character, or by the addition of something that never happened, which from being added to that which did happen changes truth into falsehood; the one producing the effect of wrong perspective, the other of faulty colouring or distortive caricature." (*L.c.*, p. 234.)

Again, when Mr. White and his helpers come to legendary and mythical Maori, and also Polynesian, stories of dogs, I have nothing to say. It only shows how badly off he (and they) must be for fitting evidence. With them all such fables are as truths. And yet Mr. White says, "The Maoris of the present day are not reliable sources for information on the *kuri*." (Paper, p. 554.) *Jam satis!* And, again, though he informs us that he does not know the Maori language save "through an inexpert interpreter," yet he *profoundly* (!) etymologically argues from certain Maori names of things, and that in a most strange manner: *e.g.* (he says), the Maoris

* Journal of Anthropological Institute, August, 1890, p. 43.

name a plant *poroporo;* its fruits are gamboge-yellow: they also call a dog *peropero:* and the similar colour of a dog which he had seen might be one reason for the coupling-together of *peropero* and *poroporo*. And again (another sample), "Some Maori told me the native name of the land known as Glenshee* [*sic*] was Kuripaka = the home or place of the brown dog." (Paper, p. 555.) Did any one ever hear of such far-fetched absolute nonsense?—reminding me strongly of that of another writer on Maori things, who (though a scholar, yet not knowing the Maori language thoroughly) made similar blunders in Maori matters *re* "the flowers" and "the fish of Hades," &c. One might as well speak of the affinity between "dog" and "dock," or "cat" and "cart," because of some of their letters being in both words.

Mr. White has very much yet to learn concerning our ancient Maori dog; also the Maori rat. I assure him he has never seen either; and I may also add, he never will. Concerning both he says, "Note that after New Zealand had been occupied by Europeans for fifty years or more the *kiore*, or native rat (*Mus maorium*) [*sic*], which was said all that time to be extinct, is now proved to exist both in the North and South Islands of New Zealand, and possibly two distinct species. . . . The fact is, a rat is just a rat, and nothing more, to the casual observer. And with the supposed extinct *kuri* it is probably the same. Having now proved beyond doubt [*sic*] that we have the original rat living side by side with the imported Norway rat, there is every encouragement to observe and search diligently in expectation of finding in a supposed Maori cur a pure descendant of the original *kuri*." (Paper, p. 554.)

"Casual observer," forsooth! Surely the many noted men of science who visited New Zealand early in this century (from Captain Duperrey in 1822 to the Antarctic Expedition in 1841), and who were all indefatigably on the *qui vive* as zoological and botanical collectors, were something more than "casual observers," particularly in the matter of the domestic dog and the frugivorous rat, then great *desiderata*. The officers of the many Government discovery and surveying ships, English, French, and American, sojourning and wintering in our harbours; the two brothers Cunningham—who resided

* I take Glenshee to be the new modern name of Mr. White's own place. Now, supposing the Maori mentioned by him had asked the meaning of "Glenshee" (phonetically rendered in Maori "Kenehi"), what satisfactory answer could Mr. White have given? Indeed, following out Mr. White's scheme of etymology, the Maori might, and probably would, have said, "Kenehi! Why, that is the name in our Maori Bible of the first book of Moses—Kenehi = Genesis. Is such your meaning? Is this place of yours so named from that?" &c.

several months in the country (1826, 1838); Bidwill, Dieffenbach, Dr. Sinclair, and Hochstetter, who travelled largely in it; Swainson, and many others; the early Governors, with all their *aides*, and numerous and good opportunities; eminent and active men of science, early residents, from the Hon. W. B. D. Mantell and Sir James Hector downwards in time—a host in themselves;—surely all these were not merely "casual observers." Moreover, the Maoris (and, mark well, *before* they had anything foreign to divert their attention and occupy their time, and when a small payment was considered a great reward), they including their old and principal chiefs and *tohungas* = skilled men (used to the snaring of rats, and everything connected with their dogs, and always bitter in their complaints against the introduced rats),* who well knew both the Maori rat and dog—these were not "casual observers." † And, lastly, the young Maoris, of various tribes and from different districts, who had been early located at our mission-stations in order to learn to read and write, and who were duly returned to their respective homes—these, stimulated by the hope of reward (promised in many cases by myself during the '30s)—these also all failed to discover a single specimen of those two animals; which, though certainly unknown to themselves, they would not have failed to detect if surviving, aided by their seniors who had well known them.

To me, and to several others (like myself, old residents in New Zealand, and not unacquainted with its natural history, who had also sought diligently throughout many years in different parts of New Zealand long before Mr. White ever saw this colony, seeking to obtain at any price specimens of both the native dog and rat), all such bold and bald statements as Mr. White has persistently put forth concerning these two animals are wholly wrong and absolutely perplexing.

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* Mr. White, in the passage I have just quoted, says, "and possibly two distinct species" (as if this was also something new). Why, this was well known so long ago as Darwin's visit to New Zealand in 1835; and I have mentioned the two foreign species in various old publications: in particular, some fine black rats (*m.* and *f.*) I obtained here living in Hawke's Bay about 1846, and, as they seemed somewhat different, sent them (in spirits) to England to Professor Owen.

† I myself, in my many long travels throughout this North Island of New Zealand,—who had also conversed with old Maori chiefs and *tohungas* who had seen Cook and his ships,—failed to obtain a single specimen.

Art. LXXII.—*On Remains of the Moa in the Forest.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 11th July, 1892.*]

When engaged in sowing grass-seed lately, on a broad clearing, I was greatly surprised to notice a collection of broken bones, intermixed with a number of highly-polished stones, which evidently were the gizzard-stones from a large bird. It is worthy of special notice that this collection was simply on the surface of the clay soil and not in the least buried, and only occupied an area of 6ft. square. As the surface of the ground had a considerable incline downward to the small gully near by, it might be supposed that any objects placed on the surface would have in the course of years a tendency to move downward into the gully-bottom. This does not seem to have been the case with these fragments, which to the finder had the same appearance as if they had not been there more than some fifteen years or thereabout.

What effect the bush-fire—that is, the burning of the felled timber—had on them I cannot say, as, to my judgment, they show no signs of burning—that is to say, such of the bones as now remain, the largest fragment of which is only some 5in. long. But it is difficult to understand how anything was left after the fire passing over. Perhaps to their position on the edge of a previous burn and of the later fire they may in a measure owe their preservation.

One of the larger pieces of bone is remarkable for a honeycomb appearance on the inside. The fragments of bone are required as evidence of the large size of the bird which made use of the stones to grind his food. These stones are by no means large compared with the size of the bird, the largest stone being only 1½in. long by 1in. across. Three others average about 1 square inch, for they may be described as very thick compared with those I remember seeing in Canterbury nearly forty years ago, which were of a kind of white quartz, broad, long, and flat, as if partly prepared for setting in a brooch. Quartz stones are not to be found here; in fact, birds find a difficulty in getting the fine-grained stones which they affect. For instance, I lately took a very large piece of glass from the gizzard of a domestic fowl, and accounted for its great thickness by supposing it was from the thick bottom of a large bottle. Its point and edges had become smooth and rounded, but it must have been full of cutting edges when swallowed. The moa-stones under description are

of material which I do not know *in sitû* or detached, but would describe them as a pale-coloured indurated slate, a grey, blue, or drab colour, or white with a shade of a darker colour difficult to explain; and they range in size down to that of a large pea, or, rather, small bean, for they are none of them round, showing that the action of the gizzard is not rotary, but what a sailor would describe as "a rubbing fore and aft." Some of these stones are of a square form; others long, and having only three corners. Most of them are so finely polished that on placing one near the tips of the fingers on the open hand they immediately slide inward to the palm, and my hand is by no means smooth, owing to the frequent use of the axe. I have little doubt the bird would have preferred a quartz stone if procurable, for even the fowl is very particular in its choice, and can be seen to pick up a pebble and pinch or, as it were, nibble it in the bill, and if it prove deficient it is at once laid aside, but if it stands the test it is swallowed.

I have no knowledge of any proof that the moa lived in the tangled forests of New Zealand, and always supposed them to inhabit grassy plains or fern-clad hills. That they fed on fern-root I have evidence in collecting the fibres of fern after they left the bird. There are remains of moa to be found on the open land of the coast some fourteen miles distant, and this bird might have travelled up the watercourse in a dry summer; but, in that case, how would he do for a drink?—for I have during one hot season seen the water near by completely dried up.

To me this find is remarkable owing to the place being in the virgin forest, and also because I have never heard of the gizzard-stones being found in conjunction with the bones of the bird which carried them. Still, on the other hand, we know that if the most of the bones are undecayed, and remain in the exact place where the bird died, the stones, which do not suffer from decay in like proportion, must therefore be still in juxtaposition with the bones, unless removed by the hand of man. The aboriginal man might possibly have considered the inside of the moa a great delicacy; in that case the gizzard would be taken away, and the stones would not be found *in sitû*.

Art. LXXIII.—*After-images.*

By Miss K. Browning.

[*Read before the Hawke's Bay Philosophical Institute, 21st July, 1892.*]

The phenomena to which I wish to draw your attention to-night are so common that my only excuses in bringing them before your notice are—firstly, the great interest I have always taken in the subject; and, secondly, the hope that if, after hearing the notes, you say to yourselves, "We knew all that before," some other member will take up the theme and tell us a little about his experiences, or throw some further light on the question.

Every one has noticed after-images, but few realise what an important bearing they have on the discussion of memory, for, unless percepts persisted for a time, we should be unable to grasp the idea that separate perceptions—say *a*, *b*, *c*, *d*, *e*—form one whole. After-images form a connecting-link between percepts and revived mental images, and they probably underlie many of the lesser acts of remembering, as Sully has well pointed out. Revived mental images are more important, because they lead to greater knowledge; but a clear understanding of after-images forms a good introduction to the subject of reproductive imagination.

It will be well at the beginning of this paper to define clearly what is meant by an image in psychology. James Sully, in his Outlines, distinguishes an "image" from a "percept" by saying that a "percept" is largely *presentative*, while an "image" is *re*presentative.

On the other hand, considering "images" under the heading of "ideas," an "image" differs from a "concept" or "general notion," for the latter deals with a class, while the former represents a concrete object or mental picture.

But the after-images I wish to speak of to-night are physiological rather than psychological phenomena; and it would have been better to have called them "after-percepts" had not the name "after-image" been better known. After-percepts of sight are the most frequent, although I have heard or read of after-percepts derived from all the organs of sense and movement. But to-night I shall deal only with the images of the organs of sight.

These images are divided into two classes—positive and negative. By a positive image we mean that colours in the representative image are of the same kind as in the presented object, while in a negative after-image the light colours become

dark and the dark light. The bright spot seen after looking at the setting sun is a good example of the first class; and I have obtained a very perfect negative image by looking at a dark photograph in a white mount. After-images are sensations, the positive being due to the continuation of the excitement of the nerve-centres, and the negative to the reaction of the nerves after excitation. Later on I shall deal with the changes of the positive into negative images.

Fechner, who was one of the great authorities on this subject, drew attention to many points of interest; but, unfortunately, he lost his sight, and was unable to complete his researches. It will be well to mention here that experiments with after-images are very trying to the eyes, and should be carried on with moderation. Many of Fechner's observations were taken in bed, and he describes how he found out that memory and knowledge play a very important part in perception. Lying in bed with his eyes open, he was under the impression that he could see the whole length of the bed, and in the memory-image he perceived the bed as he believed he had seen it. But the negative after-image showed clearly that the bed was foreshortened in the retina. Again, in the after-image the objects all appeared in one plane, while in the perception one object seemed to be further away than another.

Another peculiarity of after-images is that we cannot escape from them. Most people have noticed how painfully persistent is the after-percept of the sun or any bright light. This is due to the fact that after-images are caused by the action of the nerve-centres after excitement, and are not dependent on external objects. To obtain a good after-image, look steadily at a bright object, and then shut the eyes. The light will be distinctly visible for some time—indeed, the degree of success in obtaining a good image is largely dependent on the luminosity of the object. I have been unable to keep an after-image longer than a quarter of an hour. I was in London, and the afternoon sun was shining brightly on a polished shield, forming a brilliant point of light. I looked steadily at this object, and then shut my eyes, and covered them so that no light could interfere with the result. I then noted the various changes, and remained with my eyes covered until I could no longer perceive either a positive or negative image, even by pressing my eyeball. I looked at my watch, and found that nearly a quarter of an hour had elapsed. A lady to whom I had been talking on this subject told me that she had had a very remarkable revived after-image. She had been picking violets during the day, and in the evening she *saw distinctly* the bank where she had found the flowers.

The colours seen in these after-percepts are wonderfully pure and bright, and it has been observed that one colour may

be recalled after it has given place to another by pressure on the eyeball, either by blinking the eyes, or by touching with the hand.

The image also seems to wax and wane. This is probably due to the pulsation of blood in the arteries, for I have noticed that by moving my head I could change to some extent the colours of the image. When the eyes are shut and exposed to the light the colours of the image are, as a rule, brighter than when the eyelids are covered.

By observing the after-image my attention has frequently been called to some detail which I had not noticed in looking at the concrete object.

I will now give the results of a few experiments I have made for the purpose of noting the change of colour in after-images.

(1.) I was in a room with the window nearly covered with a dark-green blind, which did not quite reach to the top. The sun was shining brightly through this exposed part. Avoiding the glare, I looked for a second at the blue sky, which through the glass appeared almost white, then shut my eyes. Immediately I got a beautiful image—bright blue, with a dark stripe marking the wooden frame dividing the panes (which, by the way, I had not noticed with my eyes open). The blue changed into a bright violet, with a dark stripe, then to a rich yellow, which turned quickly into a deep brown with a light-grey or steel-coloured stripe down the centre. This negative image faded gradually into the surrounding dark background.

This experiment I repeated several times, with the same general results, but I found that every change in my position, by facing the light or turning my back to it, produced a different sensation.

So persistent was this after-image that I could open my eyes, look around the room without seeing the image, and shut my eyes again, when the image immediately reappeared.

(2.) I looked at the sun shining in the blue sky. The changes in colour were so rapid that I could with difficulty take note of them as they passed. But the general results were as follows: A white spot with a bright purple halo appeared in a darker purple background. The halo quickly disappeared, and the white spot changed to blue, still with a purple background; then the purple gave place to yellow, turning to orange, while the spot became yellow with a reddish background. I here pressed my eyeballs, with the result that the blue returned for an instant, but was followed immediately by orange. For a short time a green tint covered both spot and background, and after this had passed the red

and yellow tints changed places quickly; finally a yellow spot was left in a yellow background; and, when I had apparently lost sight of the image, I opened my eyes and found it again on the page of the book I had been reading.

It was curious and interesting to note how the colours would change places for a moment—an orange sun would appear on a yellow background, and suddenly give place to a yellow sun on an orange background. These changes lasting only for a moment, made the taking of accurate notes almost impossible.

(3.) I looked at the bright streak of light of a kerosene-stove, shut my eyes, but allowed the light to fall on the lids. First a yellow streak with a green halo appeared on a purple background; the halo disappeared, leaving yellow on purple; then a blue streak on a purple background, the blue gradually darkening till it appeared black, on a purple-grey background. This gave a negative image.

(4.) On trying the same experiment, but covering my eyelids, I found the image did not last as long. The yellow streak turned to orange, then to green with yellow halo, changing into dark-green, and then into a dark streak, the background being purple, varying in shade.

(5.) One evening I was walking up the Coote Road, when the presence of a persistent after-image showed me that I must have been looking unconsciously at a bright light. On recalling the circumstances I came to the conclusion that the light might have been that of a candle in the room I had just left, or that of the lamp at the corner opposite Russell's store. I walked quickly up Shakespeare Road and Clyde Road, but the image would not leave me until I reached the turning to Brewster Lane.

Examples and illustrations might be continued indefinitely, but I think I have said enough to prove that positive images change into negative, and it would be interesting if it could be shown that the changes of colour followed a fixed rule, as I am inclined to think. But, as I said before, experiments are trying to the eyes, and I found I could not continue my observations for long at one time.

I have been unable to obtain access to the latest researches on this subject, which is an interesting one, as it forms an introduction to the great subject of mental reproduction.

Art. LXXIV.—*Analogy between Light and Sound: Are they Convertible?*

By Miss Annette Wilson.

[*Read before the Otago Institute, 11th October, 1892.*]

That a certain analogy exists between light and sound has long been a recognised fact, and more or less commented on. But that that analogy should be so complete as to argue an affinity between them—nay, more, that it might even be possible to convert the one into the other—this is by no means so generally admitted.

In this idea, which I have long entertained, it would appear that I am not alone, as only a short time ago mention was made in one of the daily papers that Edison purposed making us hear noises in the sun, and this was to be effected by converting the rays forming the spectrum into sound.

It is my purpose to-night to illustrate this idea, first directing your attention to some of the remarkable analogies existing between light and sound, and then translating sound into colour, by what I believe to be a novel process or experiment, using for that purpose coloured glasses.

We know that both light and sound can be converted into heat. We also know that light, sound, and radiant heat are analogous in their laws and conditions. Professor Tyndall remarks upon this in his work upon "Sound." He says, "The action of sound is exactly the same as that of light and radiant heat. They, like sound, are wave-motions; like sound they diffuse themselves in space, diminishing in intensity according to the same law; in fact, every experiment on the refraction of light has its analogue in the refraction of sound."

Does not this alone portray the affinity of light, sound, and radiant heat, and suggest the idea that ultimately they may be found to be but different manifestations of one and the same thing, as we see illustrated by ice, water, and snow?

Let us now briefly consider the way in which light and sound are conveyed to our senses, that we may the better trace their analogy.

Light and sound, as we know, are not substances, but only the vibrations of substances, which vibrations are conveyed to our senses by pulsations through a connecting medium. Light reaches the eye by pulsations through ether, which pervades space; sound reaches the ear by pulsations through atmospheric air.

First, as to sound. Sixteen pulsations in a second are necessary to produce the lowest *musical* sound. Below that number, the pulsations, being distinctly heard, form no musical sound, only *noise*. The highest musical sound which our ears are capable of receiving requires about forty thousand pulsations in a second. Above that number a shrill noise or whistle is the result. Now, if we take the seven notes of any diatonic scale we shall find that the number of pulsations producing the seventh note, counting upwards, is *all but* double the number required to produce the lowest or first note. Thus, middle C on the piano requires 258·7 pulsations in a second; and the seventh note of the ascending scale of C—viz., B—takes 488·2 pulsations. The octave of any note takes exactly double the number of the first; therefore the octave of middle C takes 517·4. This is the pitch adopted by the Paris Conservatoire, and quoted by Deschanel in his work on "Sound and Light." There are three prominent notes in the scale, which form what is called the "common chord"; these notes are the first or keynote, the third or mediant, and the fifth or dominant. These sounds can be produced by striking any key on the piano very forcibly, with the loud pedal down, when the third and fifth of that note will be heard sounding faintly after it. In the scale of C, for instance, C, E, G, form the common chord. This satisfies the ear by itself, and is called a concord, whereas combinations of other notes in the scale are not so satisfactory to the ear, and others, again, produce complete discord.

Let us now turn to the consideration of how light is conveyed to the eye through the medium of ether.

The vibrations of light are exceedingly rapid. The lowest number that can make any impression on the retina of the eye *as light* is computed to be about four hundred and fifty billions in a second. This produces the sensation of *red*, which is the lowest colour in the spectrum. The highest colour, ultra-violet, requires about eight hundred billions, which, you will observe, is nearly double the number required for the formation of *red*. Above eight hundred billions in a second only *chemical action* is the result; below four hundred and fifty billions, *heat*.

I will here give a passage which Shellan quotes from Dove, in his "Spectrum Analysis," page 65. He says,—

"Dove describes in his own ingenious manner the course of the vibrations as they produce successively sound, heat, and light, as follows: 'In the middle of a large darkened room let us suppose a rod set in vibration, and connected with a contrivance for continually augmenting the speed of the vibrations. I enter the room at the moment when the rod is vibrating four times in a second. Neither eye nor ear tells me of the pre-

sence of the rod, only the hand, which feels the strokes when brought within their reach. The vibrations become more rapid, till when they reach the number of thirty-two in a second a deep hum strikes my ear (that is to say, the tympanum is pressed sixteen times, and sixteen times withdrawn, therefore sixteen blows are received upon the ear). The tone rises continually in pitch, and passes through all the intervening grades up to the highest, the shrillest note; then all sinks again into the former grave-like silence. While full of astonishment at what I have heard, I feel suddenly (by the increased velocity of the vibrating-rod) an agreeable warmth, as from a fire, diffusing itself from the spot whence the sound had proceeded. Still all is dark. The vibrations increase in rapidity, and a faint-red light begins to glimmer; it gradually brightens till the rod assumes a vivid red glow, then it turns to yellow, and changes through the whole range of colours up to violet, when all again is swallowed up in night. Thus nature speaks to the different senses in succession—at first a gentle word, audible only in immediate proximity; then a louder call from an ever-increasing distance; till, finally, her voice is borne on the wings of light from regions of immeasurable space.' "

This passage bears out my idea that light and sound are convertible, the one into the other, through the medium of heat.

In another place Shellan says,—

"The gradation of colour from red to ultra-violet is to the eye what the gamut is to the ear, and it is not without reason that we talk of harmony of tone and colour. To the physicist the words 'colour' and 'tone' are only different modes of expression for similar and closely-allied phenomena; they express the perception of regular movements recurring in equal periods of time, in ether producing colours, in air musical sounds, &c."

In tracing the colours in the spectrum from red to ultra-violet we notice first the three primary colours, red, yellow, and blue. Between red and yellow orange is formed; between yellow and blue comes green; and above blue we find violet and ultra-violet, which last seems on the verge of running into the red again, just as the seventh note of the musical scale, or leading note as it is called, seems to want the octave, or repetition of the keynote, to follow it—in other words, it *suggests* it to the ear.

The colours in the spectrum are arranged as follows: Red, orange, yellow, green, blue, violet, and ultra-violet (some authorities name the last two indigo and violet).

Now I come to a very important analogy. If we take the proportion of increase in the number of vibrations in a second

required to produce the seven colours, and if we take the proportion of increase in the number of vibrations in a second required to produce the seven musical sounds of a diatonic scale, we shall find these proportions *exactly the same.* Some years ago, in England, I attended a lecture entitled "The Correlation of Light and Sound," and the lecturer produced on a screen a table of the ratio of wave-lengths in a second, producing the seven colours in spectrum, and the seven notes of a scale (of course, wave-lengths vary in number in inverse ratio to their velocity). I exhibit the table which I copied at the time.

You will here see the names of the seven colours in the spectrum placed over their relations, the seven notes of a scale, with the ratio of their wave-lengths, thus:—Note C, 100 = red; D, 89 = orange; E, 80 = yellow; F, 75 = green; G, 67 = blue; A, 60 = violet; B, 53 = ultra-violet. *Any* diatonic scale would yield the same proportion of wave-lengths. Of course, the division in both is arbitrary, both sound and light being *continuous* from their lowest to their highest manifestations.

If we take the primary colours—red, yellow, and blue—in the above table we shall find that they occupy the same position in the spectrum as do the three notes forming the common chord in the scale—viz., the first, third, and fifth. Moreover, any two notes that sound discordant stand under colours that will not harmonize to the eye, and ditto *vice versâ.*

By the following illustrations on the screen I hope to make you realise the capability of colour to impress the brain in the same way as sound does the ear. I am aware that it is a very crude and inadequate attempt, but the means at my command are limited. In my mind's eye I can see a symphony of Beethoven rendered by electric flashes of coloured light, with all its grand concords and discords, producing the various emotions of peace or agitation, joy or sorrow, triumph or despair. We must remember that music began by simple melodies only, just as to-night I can give you such only *in colour.* What might not be done in the future?

Slide 1A: Colours in spectrum—red, orange, yellow, green, blue, violet, ultra-violet.

Small frames: Discord and concord.

Discord (having three secondary and one primary colour).				*Concord* (all primary colours).			
Orange.	Green.	Blue.	Ultra-violet.	Red.	Yellow.	Blue.	Red.
d	*f*	*g*	*b*	*c*	*e*	*g*	*c*

Slide 1B: Four opening bars of Beethoven's Symphony in C minor, opening in E flat major. First four notes all pri-

mary, ending on the keynote, complete and satisfactory. Second four all secondary, incomplete and unsatisfactory.

Slide 2: "Scots wha hae."
Slide 3: "Last Rose of Summer."
Slide 4: "Weel may the Keel row."
Slides 5 and 6: "God save the Queen."

N.B.—Only having been able to arrange seven colours with glasses to form one *diatonic* scale, it has been necessary to transpose each air into that one scale. With the intermediate shades, forming twelve gradations, a *chromatic* scale would be the result, corresponding to the twelve semitones in the octave, and these airs could be given in their own keys.

The twelve would be as follows:—

	1.	2.	3.	4.
Colour	Red.	Red-orange.	Orange.	Yellow-orange.
Note		c^{sharp} or d^{flat}	d	d^{sharp} or e^{flat}

	5.	6.	7.	8.
Colour ..	Yellow.	Green.	Blue-green.	Blue.
Note ..		f	f^{sharp} or g^{flat}	g

	9.	10.	11.	12.	
Colour	Blue-violet.	Violet.	Red-violet.	Ultra-violet.	Red.
Note	g^{sharp} or a^{flat}	g	a^{sharp} or b^{flat}	b	c

Art. LXXV.—*National Melodies*.

By Miss Morrison.

[*Read before the Hawke's Bay Philosophical Institute, 28th November, 1892.*]

Plate LV.

Music is poetry in sounds; melody, sounds arranged in rhythmical order. With the sounds natural to New Zealand, and the songs of different nations in New Zealand, of what character are the national melodies likely to be? To the musical artist sounds and notes for melody are to be found everywhere, as the sighing of the wind, the dash of the waves on the shore. Mendelssohn found music in the dropping of water in Fingal's Cave, and has portrayed it in his "Overture to the Hebrides." Birds have their distinct notes; but only those that have been trained by man can sing a melody. In our adopted country—New Zealand—it has seemed to me that

the original melodies of the Maoris are like chants or dirges, on four or five notes in a minor key.

The affixed manuscript (Pl. LV.) is a short air in C minor, which I have written on the idea of Maori melody. The key of C minor is acknowledged to express earnestness, and also to lend itself to the portraiture of the supernatural.

Earnestness is characteristic of the Maori, who is known to possess deep religious feeling. As the Maoris have their martial music and dance-forms, solos, recitatives, and choruses, it cannot be said that colonists are the founders of national dance and song; they have only introduced higher forms. Indeed, it seems probable that if Maoris had had the advantages of civilisation and culture which Europeans have had they would have equalled them in the developments of music.

All true colonists and Maoris are striving towards what the theosophists profess to possess—a feeling of universal brotherhood. In this country of freedom all nations can enjoy their national songs. The Englishman can sing "Britannia rules the Waves," or "The Red, White, and Blue"; the Scotchman or Irishma can have "Auld Lang Syne" or "St. Patrick's Day"; the French, "La Marseillaise"; the Germans their *volkslieder;* while the Italians have blue enough skies in New Zealand to call forth the songs of Italy. It has been observed by William Husk, librarian of the Sacred Harmonic Society, that melodies of a similar cast to those of Scotland have been found as wide apart as China and the west coast of Africa. Colonists belonging to these nations have their song in New Zealand, and will have their say in the development of New Zealand melodies. And now, with the wonderful advantages for the artist in this country, the mixture and intermarrying of different nations, the steady progress of science, and the numerous movements on foot towards the advancement of good, may we not look for a high development of national melody? In the future, when the stray traveller from New Zealand, spoken of by Macaulay, takes his stand on a span of London Bridge to sketch the ruins of St. Paul's, let us hope he will be able to sing melodies which may enlighten the remaining inhabitants of the great metropolis.

Art. LXXVI.—*Notes regarding Icebergs at the Chatham Islands.*

By A. Shand.

[*Read before the Wellington Philosophical Society, 15th February, 1893.*]

On Friday, 28th October, 1892, icebergs were seen in the northern part of Hanson Bay, in lat. 44° S., drifting, borne back and forwards under the influence of the tides between the Motukara and Te Whakuru, one berg coming in quite close, but being ultimately driven off by the wind in a south-east direction.

The next day (Saturday, 29th) an iceberg was seen from Trig. Station B, near Waitangi, in Hanson Bay, close to Ouenga, having drifted through Pitt Strait. Two or more were drifting about outside Petre Bay, one coming in possibly six miles distance from the harbour of Waitangi on the succeeding day, where large pieces could be seen broken off and floating. Further out, at the south end of the west reef, another one could be seen with a glass, apparently much larger. The one distant six miles appeared to be something between 160ft. and 200ft. in height, and about four to five hundred yards in length, precipitous, with high pinnacles on opposite ends, the centre comparatively level. Seen through a glass, the one by the west reef appeared to have the same peculiarity in having pinnacles at each end. Out in the same direction, but near the Horns (Whakahewa), a large one was seen on the 31st, estimated by the known height of the adjoining land to be not less than 500ft. in height, as its summit towered over certain parts of the land, while around numberless small ones floated about, possibly the *débris* of larger ones broken up.

The one near Ouenga appeared to be more of a razor-back in shape, sloping down to about 50ft. or 60ft. from about 180ft. in height, thence precipitous to the water's edge.

On Saturday the natives saw three large ones drifting northward through Pitt Strait in a regular procession, keeping their respective distance from one another, the hindmost one being the largest, being as large in apparent size (over 900ft. in height) as Mangere (an island possibly three-quarters of a mile in size, or more), but not so high. A number of bergs also broke up about Pitt Island, one grounding between it and South-east Island, but, beyond the general statement, I had no particulars concerning them.

The bergs in Hanson Bay kept longest in view for about a week or more, and then drifted off, owing to a strong north-west wind.

The wind two or three days prior to the arrival of the bergs had been south and south-south-west, very keen and strong; and, on the whole, from September previous, whenever the wind got to the south, it was very cold, although such happened likewise after the bergs had left, and while at the island there did not appear to be any appreciable difference in the temperature.

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

Twenty-fourth Annual Report, 1891–92.

During the past year meetings of the Board took place on the following dates: 21st August and 16th December, 1891; and 28th June, 1892.

The following gentlemen were elected to represent the incorporated societies in conformity with the Act: Messrs. J. McKerrow, F.R.A.S., S. Percy Smith, F.R.G.S., and E. Tregear, F.R.G.S.

The members who retired from the Board in conformity with clause 6 of the Act are Messrs. W. T. L. Travers, F.L.S., Thomas Mason, and W. M. Maskell, F.R.M.S.; and all these gentlemen were reappointed by His Excellency the Governor.

During the year the following gentlemen were elected honorary members of the Institute: Professor George Lincoln Goodale, M.D., LL.D., of Harvard University, Cambridge, Mass., and James W. Davis, F.G.S., F.L.S., Royal Society, Dublin.

The members now on the roll of the Institute are,—

Honorary members	30
Ordinary members—	
Auckland Institute	196
Wellington Philosophical Society ...	150
Philosophical Institute of Canterbury ...	65
Otago Institute	113
Westland Institute	70
Hawke's Bay Philosophical Institute ...	108
Nelson Philosophical Society ...	35
Making a total of	767

The volumes of Transactions now in stock are—Vol. I. (second edition), 260; Vol. V., 25; Vol. VI., 25; Vol. VII., 118; Vol. IX., 117; Vol. X., 150; Vol. XI., 40; Vol. XII., 43; Vol. XIII., 45; Vol. XIV., 65; Vol. XV., 180; Vol. XVI., 178; Vol. XVII., 180; Vol. XVIII., 160; Vol. XIX., 170; Vol. XX., 170; Vol. XXI., 100; Vol. XXII., 100; Vol. XXIII., 180; Vol. XXIV., not yet fully distributed.

The volume of the Transactions just published (XXIV.) was issued in June, and contains sixty-six articles, together with addresses and abstracts of papers which appear in the Proceedings. The volume contains 769 pages of letterpress and 51 plates. The following is a comparison of the contents of the present with that of last year's volume :—

	1892. Pages.	1891. Pages.
Miscellaneous	246	136
Zoology	358	236
Botany	44	72
Geology	28	144
Proceedings	48	48
Appendix	45	44
	769	680

The cost of printing Vol. XXIII. was £296 12s. 6d. for 680 pages, and that for Vol. XXIV. £385 13s. 9d. for 769 pages.

The Honorary Treasurer's statement of accounts shows a balance in hand in current account of £86 10s. 1d.

The amount devoted to the printing of memoirs and postponed papers (in accordance with resolution of May, 1885) is now £700.

Approved by Board.
ROBERT PHARAZYN,
Chairman.

JAMES HECTOR,
Manager.

30th August, 1892.

NEW ZEALAND INSTITUTE ACCOUNTS FOR 1891–92.

General Account.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance in hand, 6th August, 1891 ..	51	10	1	For printing Vol. XXIV.	385	13	9
Parliamentary vote for 1891–92	500	0	0	Expenses of library, alterations to fittings, and miscellaneous ..	72	3	3
Contribution from Wellington Philosophical Society	17	17	0	Carried to Memoir Account	25	0	0
				Balance in hand ..	86	10	1
	£569	7	1		£569	7	1

29th August, 1892.

W. T. L. TRAVERS,
Hon. Treasurer.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting: *13th July, 1892.*

Sir Walter Buller, President, in the chair.

The President thanked the members for electing him to the chair for the current year. He assured them he would do all in his power to promote the welfare of the Society. He would deliver his address at the end of the year.

New Members.—Major-General Schaw, C.B., R.E., Dr. Chapple, and Mr. R. B. Roy.

Papers.—1. "On Eels and their Propagation," by E. O'H. Canavan. (*Transactions*, p. 191.)

Sir James Hector said that this was a useful paper, although it did not add much to our knowledge of the subject. The Maoris could give us a great deal of information about eels. They had endeavoured to establish eels at Lake Taupo, but without success. Perhaps the Huka Falls prevented their getting there, and the soil was not favourable to their travelling overland—it was deficient in moisture. They were found in the Upper Waiau, but not in the Clarence River; the moving shingle was unfavourable. The paper rather raised a question than settled it. We must have more accurate information regarding the distribution of eels in New Zealand.

Mr. J. P. Maxwell thought that young eels could get over any difficulties in the way of travelling; they could even climb stone walls.

Mr. Maskell considered the eels in New Zealand a neglected fish. The paper would be useful in bringing the subject into more prominence. He did not think the eel was altogether a night feeder, although preferring that time. He had caught them in daylight as well as at night. The Maoris also caught them in the day-time. He had caught them 8lb. to 10lb. weight in the Clarence River, when the water was turbid.

Mr. McKay said eels travelled underground in some parts of Canterbury.

Mr. G. Beetham said the natives could not succeed in establishing eels at Taupo. Eels were not so numerous in Wanganui River as formerly; volcanic dust may have killed them. They feed in the daytime.

Sir Walter Buller said there were several distinct varieties of eels known to the Maoris, and distinguished by name. These, no doubt, all belonged to the common species, but had become slightly differentiated by their surroundings. Thus, there was a rich-flavoured white-bellied eel inhabiting the clear mountain-streams, and a dark-coloured muddy-flavoured eel inhabiting the swamps. Whatever might be thought of eels, they had always been, and were still, a valuable property to the natives of New Zealand. Those who had travelled much in the interior—

surveyors, explorers, and others—knew how comforting it was to feel that, when provisions had run short, there was always an eel for supper. To the Maoris, whose sources of food-supply were always more or less uncertain, the eels were simply invaluable. When the terms of the celebrated Treaty of Waitangi were being arranged in 1840, the first idea of the Maori tribes was the conservation of their fisheries; and at the present day there was nothing that gave a negotiator for native lands so much trouble as this ever-recurring claim as to fishing-rights. Eel-preserves were often a very important element in the determination of tribal title to land; and as long as the Maori race lasted eels would continue to be a valuable possession. The Chairman concluded his remarks with a quotation from a speech by Sir William Fox, as counsel for the Crown in the famous Rangitikei-Manawatu case, in the Native Land Court at Otaki, in the course of which, in describing the title of the Ngatiapa, he said, "They had sole and undisputed possession of the eel-ponds, and constantly resorted to them for food. Many persons—perhaps even some of the members of this Court—may not appreciate the importance of this. It has a parallel in English history. It is a fact that not only the name, but a great part of the revenue of one of the richest abbeys and cathedral churches in England, were derived from eel-ponds. The eel-fed monks led a jolly life. An old Saxon song says, 'Merry sang the monks in Ely, as King Canute went sailing by.' And in the primitive state of life which existed on this coast in 1840, the eel-ponds between Manawatu and Rangitikei were worth more than a gold-mine to the natives resident there. Kereopa said truly—at that time the eel-preserves were the great property in that part of the country, and he, a Ngatiraukawa, adds, 'They were all held by the Ngatiapa, and they have retained possession of them to the present day.' To European minds, cultivation may seem a more important exercise of ownership than habitual fishing in eel-ponds; but in New Zealand it is just the reverse. The preserves in question swarm with millions of them. On one visit paid by the Superintendent of Wellington [the late Dr. Featherston] to that district, he was presented with a dish of twenty thousand eels for dinner. You may grow potatoes or feed sheep anywhere, but eels can only be got where Nature causes them to be. A great eel-fishery like that between Manawatu and Rangitikei is of as much value to the natives as the banks of Newfoundland or the Bay of Fundy to those who deal in codfish. I contend that, if the Ngatiraukawa had been as thick over that land as the eels are in its ponds, the undisputed exercise of the right of fishery in the hands of the Ngatiapa would have been proof that the mana of the district was still with them. To enjoy the right of fishing, the right to the adjacent land is essential; and there is no ingredient of so much weight in all this case to prove the continuance of the Ngatiapa mana in the disputed block as their holding on to the eel-ponds."

2. "Notes on New Zealand Birds," by Sir W. Buller (with specimens in illustration). (*Transactions*, p. 53.)

Before proceeding to his notes, the author bore testimony to the great service rendered by the late Governor, Lord Onslow, in his memorandum for Ministers recommending the setting-apart of the Little Barrier at the North, and Resolution Island in the South, as perpetual reserves for the conservation of the indigenous fauna and flora; and he said that the Hon. Mr. Ballance had earned the hearty thanks of every ornithologist by the prompt action he had taken in order to give effect to the Governor's proposals. The President quoted from the papers on the subject now before both Houses of the General Assembly, and explained shortly how the scheme would be carried out. The specimens exhibited were a creamy-yellow-coloured *Anthornis melanura*, and a parrakeet (*Platycercus novæ-zealandiæ*) largely marked with canary-yellow.

Mr. Maskell doubted as to whether these winged birds could be kept on the islands, and questioned if the food on the islands would suit all the birds it was proposed to conserve—the huia, for instance. If they were sure of this it would be a good thing done.

Sir W. Buller said he considered the plan would answer well in every way. The huia adapted itself to almost every place.

3. Sir W. Buller exhibited two very interesting Maori objects, namely,—

(1.) A *kapu*, or carved funnel, used in former times for conveying water into the mouths of chiefs who were in a *tapu* or sacred condition, and therefore unable to touch food with their hands, or to permit themselves to be touched by the hands of others. This condition always followed the *hahunga*, or scraping of human bones before depositing them in their final resting-place, as well as other religious ceremonies, and lasted until the subjects had undergone the function of *whakanoanga* or purification. On these occasions the *tohungas* or other "sacred persons" squatted on the ground with their hands behind them, and were fed by young girls, who, using a fern-stalk after the manner of a fork, tended them with cooked food from a *kono*, or open green-flax basket, and at intervals poured water into their mouths from a calabash by means of a *kapu* or funnel.

The specimen exhibited was dug up in an old limestone-cave deposit at the Bay of Islands, and is evidently of extreme age. It is fashioned out of seasoned kotukutuku, or native fuchsia, and the shell-carving with which it is embellished all over is of an ancient type, and very curious in its design. There are two specimens in the British Museum (one of them presented by Sir George Grey, about the year 1852), and another in the Ethnological Museum at Cambridge, and these are the only ones of which we have any knowledge. So far as colonial collections are concerned the specimen exhibited is quite unique.

(2.) A *kaea*, or Maori war-trumpet. This instrument is now extremely rare. There is a specimen in the British Museum, and another in the Ethnographical Museum at Berlin, but so far as is known there is no other example in the colony. This specimen is nearly 5ft. in length, and has a firm outer lashing of split kareao, or "supple-jack," whereas the British Museum specimen, which is apparently of more modern construction, is bound round in its whole length with strong whipcord. The most interesting feature in this sounding instrument is an ingenious contrivance, in imitation, it is said, of the human tonsil, about a foot within the larger orifice. In the hands of a practised Maori warrior this trumpet is capable of producing a very extraordinary and

far-reaching call; but few Maoris of the present generation are able to sound it.

4. "Notes on a Land Planarian, collected by F. V. Knapp, Nelson," by Sir James Hector. (*Transactions*, p. 255.)

The author gave an account of the specimens previously found, and of this family generally, and described their distribution in Australia and New Zealand. He urged collectors to be on the look-out for them.

Mr. Maskell said that the black swamps were full of such worms.

Mr. Hudson had observed them in Wellington after rain, brown and red in colour.

Sir James Hector laid on the table and remarked on the following exhibits: 1. Two lizards. 2. Fish from Paraparaumu. 3. Fossils collected by the Geological Survey. 4. Lithographic stone found in Mongonui district by Geological Survey, with a specimen prepared and drawing on it. 5. Fossil barnacle. 6. Rocks from Hikurangi, which fix the coal-measures as being identical with those in South Island. 7. Black gum out of swamp; giving a description of the various gums and their value.

Mr. G. V. Hudson exhibited some butterflies, mounted by himself.

SECOND MEETING: *3rd August, 1892.*

Sir Walter Buller, President, in the chair.

New Member.—Mr. Cyril Tanner.

Papers.—1. "On a New Zealand Variety of *Floscularia coronetta*, Cubitt," by Archdeacon Stock, B.A.; communicated by Mr. W. M. Maskell. (*Transactions*, p. 193.)

Mr. Maskell gave a general description of these minute animals, and said they were most beautiful objects under the microscope. He said they were very easily collected.

Mr. Powles said he had obtained good samples in the ponds in the Botanic Gardens.

2. "On a Diatom Deposit at Pakaraka, Bay of Islands," by A. McKay, F.G.S. (*Transactions*, p. 375.)

Sir James Hector described the locality where this deposit occurs as a small lagoon that is fed by an underground passage from a lake south-east of the volcanic hill Parerua. The hollow has been formed by the intrusion of ancient lava-streams. It dries up frequently, and the diatoms with which it swarms then die, and their siliceous remains form a layer which bleaches. When the pool again fills with the naturally-filtered water a fresh crop grows, and the species that predominate no doubt depends on the season of the year at which this takes place, and thus causes the great variety observed.

Mr. Maskell said that, as Mr. McKay had referred to him in the paper, it was necessary that he should say a few words upon the matter. He would not give any opinion whatsoever as to the geological aspect of

it, as he had no pretension to any knowledge of geology. But when last year Mr. McKay asked him to examine microscopically this deposit, he was impressed by so marked a difference between the diatom growth on the surface-grasses and water-weeds and the diatoms in the earth itself, and suggested to Mr. McKay to have a further examination of it. It might be well, perhaps, to remind the meeting that by "diatoms" are meant a number of excessively minute organisms existing in fresh or salt water, which naturalists nowadays unanimously agreed to consider as plants. These plants, almost inconceivably minute as they are, consist very largely of a hard purely-siliceous skeleton, with (doubtfully) some mucous substance either enclosed by or surrounding the flinty mass. In life diatoms might be either attached by stalks to weeds, or free and stalkless, and in many instances were endowed with a power of motion in the water which nobody had yet been able to satisfactorily explain. When dead the flinty skeleton alone remained, and this, falling to the bottom of the water, went to build up the substance known as "diatomaceous earth," of which the present was a specimen. Further, in most instances it was possible to distinguish living and dead diatoms by the presence in the former of "endochrome," internal colouring-matter, probably part of the mucous portion of the plant. Now, the difference which, in 1891, he had noted in the material submitted by Mr. McKay was that, in the surface-growth of diatoms, mostly still alive, the vast majority of the plants seen belonged to a common, widely-spread genus—*Melosira*, with some very minute *Naviculæ*—while in the deposit then taken from 1ft. in the earth there are also large numbers of an entirely different diatom, which Mr. Grove (the leading English authority) referred to the genus *Achnanthes*. This change led him to suggest to Mr. McKay a further examination, and the result was that ten samples were this year collected and submitted to the speaker, one for each foot of depth (besides the surface-growth), the whole deposit being 9ft. thick Of this he had made very careful examination, taking five specimen slides from each sample, or fifty in all; and the result not only confirmed his diagnosis of 1891, but revealed further rather curious changes in the genera seen. Whilst *Melosira* and *Navicula* formed all through the vast majority of the diatoms, *Achnanthes* exhibited rather curious oscillations, being strikingly plentiful at certain depths, and exceedingly rare, if not absent, at others. Moreover, there were three other genera—*Surirella*, *Pinnularia*, and *Epithemia* (all of which are by no means uncommon in many New Zealand deposits)—which occurred in large numbers at the depths of 8ft. and 9ft., but which then ceased to appear, being entirely absent from the higher parts of the deposit. These oscillations of genera seemed to the speaker to be worthy of remark, and perhaps of still further inquiry. Mr. McKay was of opinion that a period of several thousand years must have elapsed since the deposit was first commenced. If this was correct, it would appear that some changes, climatic or other, must have occurred at intervals, resulting in the prevalence or the diminution of the various genera named. The speaker founded no theory whatever on the facts observed, merely relating these as seeming to be worthy of record and possibly of further examination.

Specimens of the diatoms were then examined under the microscope by the members.

After the reading of the papers, Mr. McKay exhibited with the lantern a series of views of New Zealand scenery, chiefly of the West Coast. They were intended principally to show the geological character of the country.

THIRD MEETING: *24th August, 1892.*

Sir Walter Buller, President, in the chair.

Paper.—"On the Extinction of the Moa," by E. Tregear, F.R.G.S. (*Transactions*, p. 413.)

Sir W. Buller said that, as the author had pointedly mentioned his story of the pet moa, he would explain the reference. At the hearing of the great Rangatira Block case in the Native Land Court in 1882, he (the speaker) acted as counsel for the Ngatiapa Tribe. The title to the block of land in dispute was closely contested at every point by the rival tribes; but one piece of traditional history was accepted by both sides as true—this was the story of the pet bird of the Ngatituwharetoa. Instead of belonging to the "land of pure myth," this story recounted an incident in the history of the Ngatiapa Tribe; and the account given by a witness well versed in the traditions of the people was as follows: Apahapaitaketake, an ancestor of the Ngatiapa people, stole a moa which was a pet bird of the Ngatituwharetoa. While doing so he fell over a cliff and broke his thigh, and was thenceforward nicknamed "Hapakoki" (Hop-and-go-one). He got off with the moa in spite of this. When the Ngatituwharetoa heard of this outrage, they came down upon his place and carried off his wife, Hinemoatu, in payment for the moa which he had stolen. Then Hapakoki, in great wrath, went and seized the kumaras of Kawerau; and the Ngatituwharetoa, in equal wrath, made an attack on the Ngatiapa. As the result of all this, the Ngatiapa left the Bay of Plenty district, and came to Maunganui, in the Upper Rangitikei, where they were again attacked by the Ngatituwharetoa, who had pursued them from Te Awa-o-te-atua. Then the Ngatiapa moved on south, and settled on the north-east side of the Taupo Lake; but they were followed up and again attacked, after which they moved on to Tawhare-papaama and Moturoa, south of Taupo and close to Rotoaira, on the edge of the lake of that name, whence they subsequently migrated to the coast and settled down between the Wangaehu and Manawatu Rivers. Now, this was a pretty-well-authenticated story—accepted, at any rate, by rival factions in Court as historically true—showing that the moa was not only well known to the ancestors of the present race of Maoris, but that it was capable of domestication, and that a tame one had been an important factor in the tribal history of the Ngatiapa. It might be urged that this was an isolated case, but he would submit that, even so, it was a sufficient answer to the sweeping assertion that the ancient Maori knew nothing about the moa or its existence. He quite agreed with Mr. Tregear that it was desirable to treat the whole question from an impersonal point of view. The subject had been so much discussed and speculated upon for years past that the band of scientists and workers in New Zealand had, as it were, divided themselves into two schools. There were those represented by the late Sir Julius von Haast, including Professor Hutton, Mr. Colenso, Mr. Stack, and others, who believed that the moa became extinct at a remote date, perhaps many thousands of years ago; and those represented by Sir James Hector, Mr. Mantell, Mr. Travers, Mr. Maskell, and many others, including himself, who held to the theory that some, at any rate, of the species of *Dinornis*, if not the more colossal ones, had survived to within a comparatively recent period, and had been finally killed off by the ancestors of the present race of Maoris. Sir W. Buller proceeded to give numerous facts in support of the latter contention. He added that the late Professor De Quatrefages had, in a masterly review of the whole of the literature on this subject, arrived at a similar conclusion; and he quoted several passages from a translation of that memoir ("Les Moas et les Chasseurs de Moas") made by Miss

Buller, and laid on the table at a former meeting of the Society. He concluded by saying that, although Mr. Tregear, from a philological treatment of the subject, appeared to have arrived at an opposite conclusion, he had listened to the paper with much interest, because it was a very suggestive one and opened up new lines of thought.

Mr. Travers considered that the moa existed as a living bird within a limited period. He referred to Mr. White's description of the hunting of the moa, and to the traditions on the subject. He had no doubt about the evidence that the ancestors of the present race of Maoris had eaten this bird. The finds of bones at Oamaru and elsewhere would prove that the existence was comparatively recent. The Maoris must have known about the moa. A moa's egg was found buried with a chief. The egg and chick, the latter in the embryo state, found in Otago would bear out the recent theory. He did not think it could have meant the common fowl. The word "moa" was given to a bird tall and graceful in its movements. We could not judge of this matter from the Maoris of the present day, but fifty years ago they were familiar with the existence of this bird. It was strange that so many species of this gigantic bird should have existed in New Zealand.

Mr. Harding did not think Mr. White altogether a safe guide on this matter. The place mentioned by Mr. White where a moa was destroyed was actually occupied by Europeans, and yet they did not seem to have made this fact known. As to the preservation of the moa-remains, it was well known that seeds, bones, &c., might be preserved for thousands of years if they were protected from destroying agencies. The natives very often gave information that they thought would please those asking them.

Mr. Maskell said that, if Mr. Harding's views about the Maoris were correct, they entirely bore out his contention that Maori traditions on such matters were valueless. It stood to reason that, if a Maori was ready to invent a tradition about moas out of courtesy to a white man, then the reliance to be placed on any Maori traditions whatever could only be infinitesimal; and, further, it must be clear that neither the absence nor presence of a tradition could form an argument of any value at all. In point of fact, the "traditions" of savage or semi-savage races which had not a literature of any kind must necessarily be valueless the moment they extended beyond the domain of ordinary domestic affairs, or distinct actions of perhaps two or three generations ago. He quite agreed with the President as to the very great importance of the paper by M. De Quatrefages, and he was proud of having been the first to bring that paper under the notice of the people of the colony several years ago, in the pages of the "New Zealand Journal of Science." As for the philological aspect of the question, it still seemed to him, as he had said on former occasions, that by merely taking words of different languages, and comparing their spelling and sounds, especially if such spelling and sounds were not those of the natives, but those of missionaries, a man might prove to his own satisfaction every conceivable theory. Philology so confined was no real service. The important points for consideration in comparative philology were grammar and syntax, and mere verbal resemblances were not, taken alone, valuable. To return to tradition, whilst he thought little of Maori legends, he did value European tradition, and he well remembered hearing the late Sir F. Weld state often that, when he started from Nelson, somewhere about 1848, to make the first overland journey to what is now Canterbury, the Maoris warned him to be very careful of the large birds which he would meet in the mountains, and which would kick him to death if they could. That was a tradition worth any number of volumes filled with Maori legends.

Mr. A. McKay thought the discussion had drifted from the subject of Mr. Tregear's paper. As regards moa-remains, they were to be found in

or near almost every Maori encampment between Cape Campbell and Catlin's River in Otago; and the question was, Were there in the South Island a race anterior to the Maoris who alone knew the moa? If so, it was strange that the Maoris afterwards occupied every encampment in which moa-remains were to be found. It therefore was a question of moa and Maori or moa and a race anterior to the Maori.

Mr. Tregear, in reply, said that his paper had been misunderstood by most of the speakers, as it had been considered to imply that he considered the *Dinornis* to have been destroyed at an immense distance of time ago. What he had endeavoured to show was that allusions in folklore and mythology, which had hitherto been taken as evidence that the Maori was acquainted with the *Dinornis*, were unreliable for this purpose; and he had started a new line of inquiry. As to the value of comparative philology, whatever a single person in his audience might say, it was too well acknowledged as of worth by the greatest minds of the age to need defence. How to reconcile the absence of allusion in tradition and the statements of old chiefs about "the days of the Deluge" with the apparent freshness of the remains exhibited by naturalists the speaker did not know; but he felt certain that one day the true explanation would be furnished, and then every one would be surprised at its simplicity. In the meantime any one who could lend assistance by purifying what was called "the evidence on the subject" was doing some service, however slight.

The President exhibited and made remarks upon an albino sparrow (*Passer domesticus*) from Nelson, in which the entire plumage was of the purest white.

Fourth Meeting: *14th September, 1892.*

Sir Walter Buller, President, in the chair.

Papers.—1. "On the Antarctic Seals," by Sir James Hector. (*Transactions*, p. 255.)

Sir W. Buller had considered the specimen referred to as being in Mr. Drew's collection to be an albino, but after Sir James Hector's description he had no doubt about its being the sea-leopard. He had some fine seal-tusks given him by the natives, which he would exhibit at a future meeting.

2. "On an Ant-like Insect (*Betyla fulva*, Cameron) parasitic in the New Zealand Glowworm," by G. V. Hudson, F.E.S. (*Transactions*, p. 164.)

The author stated that he had forwarded the specimen to Mr. Saunders, in England, for description.

Mr. Maskell asked Mr. Hudson whether this might not be a parasite that lays its eggs on the eggs of the insect.

Mr. Hudson said that some were found in the eggs and some were parasitic in the larvæ.

3. The President called attention to a number of articles on the table made from Taranaki ironsand, which were exhibited by Mr. E. M. Smith, M.H.R. The articles consisted of buckets, bolts, carriage-steps, a fly-wheel, a ratchet-wheel, also horse-shoes, and various other articles.

Mr. Smith explained that the castings were effected at the Onehunga Ironworks, whilst the malleable portion of the exhibits was the work of Messrs. Luke and Son, of Wellington. A pan of the ironsand was shown; and it was stated that 85 per cent. of the sand is virgin iron. Mr. Smith gave a most interesting account of the process employed in the manufacture of these articles, and declared that they could be made 25 per cent. cheaper and 25 per cent. better than similar imported articles.

In answer to Mr. Higginson, Mr. Smith stated that the Taranaki iron had been tested for strength, and had been proved 2½ tons over best B.B.H. iron; and the report was in the Assembly Library.

Sir James Hector remarked that he had recommended Mr. Smith to send samples of the iron recently manufactured to the Engineering School, Canterbury College, where all the necessary appliances for testing were to be kept.

Sir W. Buller asked Mr. Smith how it was that, notwithstanding his great exertions to develope this important industry, all attempts up to the present had failed.

Mr. Smith replied that it was through no fault of the material, but owing to the apathy of those engaged in the work, and who did not push the matter as it deserved.

Replying to a vote of thanks, Mr. Smith remarked that he desired to express his thanks to Sir James Hector for the very kind and valuable assistance he had invariably given him.

Fifth Meeting: *5th October, 1892.*

Sir Walter Buller, President, in the chair.

Papers.—1. "On a Maori *Waiata*, or Song," by R. C. Bruce, M.H.R. (*Transactions*, p. 426.)

Mr. Tregear said that Mr. Bruce deserved the thanks of the Society for having brought this beautiful poem to light. It was of great value historically, as well as from a poetical point of view. He thought, however, it might have been in part adapted from some other old song, and not altogether an original composition by the old chief mentioned.

Sir James Hector said the chief interest of this *waiata* was the mention of the hokioi associated with the moa. The hokioi had been identified as a huge vulturine bird that preyed on the moa and was now quite extinct. The bones were first identified and described by the late Sir J. von Haast. He (the speaker) then exhibited two photographs of a very fine skull of this bird recently taken by Mr. Hamilton, of Dunedin.

Sir W. Buller, whilst testifying to the historical interest attaching to the *waiata*, expressed a doubt as to its entire originality. He had heard it alleged by other natives that it was only an adaptation by Te Hakeke. That this chief was, however, a man of renown and individuality was admitted on all hands. His son, the late Kawana Hunia te Hakeke, inherited these qualities; indeed, he was one of the most capable and remarkable men of his day. With a devotion beyond all praise, he spent his whole life in continuous and never-ceasing efforts to restore the fallen fortunes of his tribe. Bishop Hadfield had described in graphic language the deplorable condition of the Ngatiapa Tribe when he first came to the coast. Chiefly through the exertions of Kawana Hunia the tribe had been completely rehabilitated, and had recovered possession of all its ancestral lands. He was glad to have this opportunity of paying a tribute to the unselfish character of the late Kawana Hunia. He was inclined to think that the hokioi referred to was really the frigate-bird.

Captain Mair said that traditions indicated that the hokioi was a very large bird of prey, and that it could not have been the frigate-bird that was intended.

The Chairman was still inclined to think it was the frigate-bird, which was a true bird of prey—in fact, the vulture of the ocean.

Mr. Bruce, in reply, was glad to find that his communication had so much interest. He might remark that, if the description of the colour of the hokioi given in the *waiata* was to be taken as reliable, it could not have been the frigate-bird that was intended.

2. "On the Antiquity of the Moa," by Captain G. Mair.

Abstract.

The author referred to the large amount of information collected bearing on the moa. He considered that the probable extinction of the moa could only be fixed approximately after all the evidence had been exhausted. He quoted numerous Maori traditions and accounts given him by old natives, showing the several localities—five or six in number—where, fifteen or sixteen generations ago, solitary moas were reputed to exist. He gave the history of two *pikis*, or head-dresses, made from moa-feathers, and named Te Rauamoa and Te Rauopiopio, which were famous in former times, and to which there are numerous allusions in songs and proverbs. He pointed out the extraordinary and fabulous accounts given by the natives, which proved that it was impossible that their immediate or even remote ancestors could have possessed any intimate or reliable knowledge of the moa; that among the vast number of histories of blocks inquired into by the Native Land Court hardly any allusion had ever been made to moas. He gave instances of the extraordinary preservation of human bodies under certain conditions after death, and suggested that the specimens of moa-remains found in an almost fresh condition had probably been preserved in some such manner. The conclusion he came to was that the moa was exterminated at least twelve generations ago.

Mr. Field said he could produce evidence to prove that the moa was in existence in these Islands not more than fifty years ago. There were numbers of natives who knew all about the moas, and who had eaten them. They described how they killed men by striking out in front with the foot. He believed the chief cause of their disappearance was that the wild pigs had destroyed their eggs. He had seen undoubted moa-feathers. He described how the bones were cut with a sharp instrument, evidently a tomahawk introduced by Europeans. He would send down all the evidence he could collect bearing on the subject.

Sir W. Buller stated that struthious birds are in the habit of striking downwards with the foot, lifting it towards the breast. As to the head-dress of moa-feathers said to have been in possession of the late Rev. R. Taylor, this relic was now in the collection of Mr. Henry Harper, of Wanganui. He (the speaker) had recently examined it. The plumes were only cassowary-feathers, and the mounting was split bamboo or rattan from the islands.

Mr. Tregear said that the legends read by Captain Mair were some of them quite new and valuable. The remarks regarding the feather plumes quite bore out what he thought formerly as to the Maori not knowing the *Dinornis*. "Rauamoa" evidently meant "a plume belonging to (a man's name) Moa," and "Rauopiopio" showed that it was a plume of the bird piopio. This piopio was not the thrush (*Turnagra hectori*), but a lost bird; certainly not *Dinornis*. The real feathers of the *Dinornis* had all been discovered by naturalists or geologists, and were not found in possession of Maoris. When Maoris of to-day had legends to tell concerning the moa they were all of such preposterous and mythical character that they proved the truth of what the old chiefs of fifty years ago alleged—

viz., "That neither they nor their forefathers had ever seen the moa, because the last moas were destroyed at the time of the Deluge." That the *Dinornis* had been killed and cooked by men in New Zealand was certain from the geological evidence, but that the Polynesian Maori had known the *Dinornis* at all was highly improbable. Possibly vague accounts had been handed down from the prehistoric inhabitants (moa-hunters), with whom it was almost certain the Polynesian immigrants had intermarried.

Mr. Maskell did not think Maori stories were worth much as evidence in this matter of the moa. He considered the following facts were worth all the legends that could be brought forward: (1.) A certain Maori told Colonel McDonnell that he had hunted and killed the moa, and pointed out the place where the bones would be found, and where they were found. (2.) Moa-bones lay in millions on the open ground in the South Island, in Canterbury, where there was not likely ever to have been dense vegetation. Would they, under such circumstances, last for generations? (3.) Sir F. Weld asserted that, when making a journey into the interior shortly after 1840, he had been warned by natives to look out for the big bird that he might meet on the mountains, and that would kick a man to death.

Captain Mair, in reply, said that no doubt the story referred to was told to Colonel McDonnell to please him. The vegetation where bones were found in the North was quite thick, and he did not see why it should not have been equally dense in the South at some period. The story told to Sir F. Weld was merely told to alarm him. This was often done by the natives; he had been told things of this kind himself. The bones found on the line of General Cameron's march were probably beef-bones. He did not think the Maoris knew anything concerning the moa even for eight generations back.

3. The President exhibited a skin of the true hedge-sparrow (*Accentor modularis*), killed in the suburbs of Wellington, which had been sent to him by Mr. Capper for identification. He remarked that it was most satisfactory to have this tangible proof that this very useful bird had become acclimatised in this country. He had several times observed it in his own garden in Wellington, hunting for insects in the shade of trees, and there was every reason to hope that it would increase and multiply.

4. The President also exhibited a beautiful specimen of the white tern (*Gygis alba*) from the Kermadec Islands. He mentioned that this species, instead of depositing its eggs on rocks, or on the sands of the sea-shore, like the rest, placed them on boughs of trees overhanging the water.

5. "Note on the *Mus maorium*, Hutton," with specimen, by Sir W. Buller. (*Transactions*, p. 49.)

Captain Mair remarked that this little rat was exactly similar to that inhabiting White Island, in the Bay of Plenty.

Sir James Hector said that this rat was entirely different from some others sent from Nelson at the time of the irruption of rats referred to, and which he was unable to distinguish from *Mus rattus*.

SIXTH MEETING: *26th October, 1892.*

Sir Walter Buller, President, in the chair.

New Members.—Mr. B. M. Molineaux and Mr. H. J. Freeman.

Papers.—1. "On Unwritten Literature," by R. C. Harding. (*Transactions*, p. 439.)

Mr. Hulke agreed that the lore of the people referred to by the author was quite as valuable as that of our own. He did not think that real genuine poetic feeling would die out as was supposed, however hard we had to fight the battle of life. The Maori was quite as poetical as those gone before.

Mr. Maskell considered this paper a most valuable contribution; it required to be read carefully before any proper discussion could take place on the subject treated. He would take an early opportunity of writing an answer to this paper, as there were many points on which he differed from the author. It was the tendency of the age to look down on the emotional side of things, and to give too great prominence to the practical and purely scientific; but nature would assert itself. The modern tendency was to discourage literature and foster technical science, but he did not think this would succeed.

Sir W. Buller complimented Mr. Harding on his paper, but took exception to some of his observations. The speaker referred to the peculiarities of Maori tradition and poetry, and testified to the marvellous powers of memory possessed by these custodians of an "unwritten literature." He had heard a Maori for hours together recounting tribal and family genealogies without once faltering or tripping—genealogies throwing quite into the shade the longest of those given in the Scriptures. He dwelt on the flexible character of the Maori language—its euphony, and the idioms, which lent themselves so readily to poetry. Some of the books of the Old Testament, such as the "Song of Solomon," were confessedly more beautiful in Maori than in English. Many of the poems possessed a high order of merit; and the collection, or rather selection, made by Sir George Grey, and published under the title of "Poetry of New Zealand," was a very important contribution to Polynesian literature, the only regret being that no translation had ever appeared. The speaker doubted, indeed, whether it would be possible now to get many of these poems translated, their references being too obscure, and their language that of the race of *tohungas* or priests, who had now passed away. Twenty years ago, when he, the speaker, first met Professor Max Müller at Oxford, that distinguished scholar sent his regards to Sir George Grey, and a request for the long-promised translation. Sir W. Buller said he did not wish to underrate Mr. Colenso's labours in the same direction, but he considered Sir George Grey's volume of "Maori Proverbs" (published subsequently to the "Poetry") far and away the most complete collection in existence. This book was now extremely scarce, and, for the sake of Polynesian literature, he would be glad to see the New Zealand Government undertake its republication.

Mr. Harding, in reply, said that he was agreeably surprised that his paper had been received so well. What he had wished to imply was that the *appreciation* of poetry was dying out, not that poetry itself was disappearing.

2. "On some Mites parasitic on Beetles and Woodlice," by W. M. Maskell. (*Transactions*, p. 199.)

Mr. Hudson exhibited two beetles with the parasite on them. He remarked that he did not think that attention should be wholly devoted

to the description of those insects that were injurious or otherwise to man; attention should also be given to the general study of insects.

Mr. Maskell pointed out that he always gave the scientific descriptions of the insects he treated, but abstained from reading them at the meetings.

3. The Chairman drew attention to some pieces of pottery and copper nails, &c., found by Mr. Capper at Lyall's Bay, near a wreck. The pottery was carbonaceous, and it was generally thought that the nails were of French make.

4. "On the Bats of New Zealand," by Sir W. Buller. (*Transactions*, p. 50.)

5. "On a Blue-necked Crested Shag (*Phalacrocorax nycthemerus*) from Antipodes Island," by Sir W. Buller.

6. The Chairman also exhibited specimens of the flightless rail from Chatham Islands (*Cabalus modestus*), supposed to be extinct, and the only rail that has a curved bill. (*Transactions*, p. 52.)

SEVENTH MEETING: *7th December, 1892.*

Sir Walter Buller, President, in the chair.

New Member.—Mr. Henry Wright.

The Secretary announced that Sir W. Buller, Mr. J. McKerrow, and Mr. S. Percy Smith had been elected Governors of the New Zealand Institute, to represent the incorporated societies, for the ensuing year.

Papers.—1. "Synonymical Notes on New Zealand *Cicadidæ*," by G. V. Hudson. (*Transactions*, p. 162.)

Sir James Hector thought it quite right for naturalists to give their reasons for what they had done when questioned as to the correctness of their descriptions.

The Chairman also thought that Mr. Hudson had taken the proper course in this matter.

2. "Observations on Rainbows," by R. C. Harding. (*Transactions*, p. 448.)

Sir James Hector said that he had seen double lunar bows in high latitudes; and in the case of lunar halos, where the effect was produced by the diffractive influence of ice-spiculæ, the arches were often numerous, and made complicated figures.

Mr. Hudson had seen two lunar rainbows.

Mr. Maskell said that Mr. Harding's paper, as was usual with him, suggested points outside the ostensible ones treated of, and he should like to draw attention to one of them. In De Morgan's "Budget of Paradoxes," a most amusing and instructive book, mention was made (he forgot the page) of a picture exhibited in London many years ago at the Royal Academy, in which the artist painted a rainbow reflected in a lake. The picture was variously criticized. Artists said it was quite right. Some scientists said it was all wrong; others were doubtful. De Morgan, in his book, did not decide the point, but seemed to indicate that everybody was wrong all round. The speaker had seen the point referred to in several

scientific treatises, but in none was any positive decision given. Now, could a rainbow be seen reflected in the water? If not, why not? If so, at what angles must the rays strike the water after emergence from the raindrops so as to produce on the eye exactly correct colours after the double reflection, and perhaps quadruple refraction? Personally, he rather thought that it could not be so reflected, but would like to hear what more competent authorities could say on the point. With regard to lunar rainbows, he could very well recollect seeing in Wellington on one night in 1860, when a heavy dark cloud was rolling up from the south, a perfectly-formed arch on the cloud, but quite white and shining, without any trace of colour. The moon at the time was quite or almost full.

General Schaw was inclined to think that the reflection could not be seen. In regard to what Mr. Harding had said of the reflection of the moon, Ruskin stated that it was parallel on the water.

Sir James Hector said the shape of the moon's reflection to the eye depended on the state of the surface of the water. An absolutely still surface would only reflect one image. The more agitated the surface the wider the band of light owing to multiple reflection.

Mr. Tregear, in referring to a remark by Mr. Harding "that artists were often very incorrect, while poets were the more truthful in their descriptions of nature," said that undoubtedly the higher poets were wonderfully close observers of nature: indeed, the faculty of extraordinary insight and observation was one of the proofs of artistic genius. He would instance the remark of a farmer who said that he had been among English woods all his life, but never noticed the intense blackness of the buds of the ash until he read Tennyson's line,—

> As black as ash-buds in the front of March.

He did not know if it had been before brought to the notice of the Society that Shakspeare, in "Troilus and Cressida," had said,—

> My love is as the centre of the earth,
> Drawing all things into it.

This in a day when things were believed to fall by their own weight. The poet thus in a few concise words anticipates the theory of gravitation set forth years after by Newton.

3. "On a New Insectivorous Plant in New Zealand," by Sir W. Buller. (*Transactions*, p. 302.)

Mr. Kirk said that insectivorous plants were generally known in New Zealand. There were three or four different kinds, but he had not observed the peculiar carnivorous properties mentioned in the one now described. It was more frequent in the pitcher plants; and he proceeded to describe, in some detail, the existence of bladders in plants of this description. Sir J. Hooker deserved the same honour as Mr. Darwin for his discovery in this direction.

Mr. Hudson and Sir James Hector had seen specimens of this fungus near Wellington.

Sir W. Buller said he was glad that Mr. Kirk had so readily accepted his conclusions, seeing that he was an acknowledged authority on New Zealand botany. He was pleased to hear that gentleman so unhesitatingly affirm his belief that the fungus described by the author possessed the power of assimilating the albumen contained in the bodies of the insects, and applying the matter so absorbed to its own nourishment. The other New Zealand plants mentioned by Mr. Kirk belonged, all of them, to the family *Droseraceæ*. The plants furnished with minute bladders, of which he had given such interesting particulars, belonged to a natural group, of which Mr. Darwin had given us a full account in his work on "Insectivorous Plants." The curious thing about this one was, as Mr. Kirk would admit, that it was a plant of an entirely different

order. The points which he had desired to emphasize in his notice of this fungus were, in the first place, its faculty of attracting insects by means of its brilliant flower-like appearance, coupled with the pungent odour of its viscid secretion; and, secondly, its power of digesting and absorbing them into its own system after being caught. The "sea-anemone" form of *Aseroë*, referred to by Sir James Hector as occurring at the Hutt, must be an entirely distinct species, and was deserving of attention, the only two New Zealand forms at present known to botanists being *A. rubra* and *A. hookeri*. As to Sir J. Hooker's undoubted share in the credit of the discovery as to the carnivorous properties of *Drosera*, he might mention that on the occasion of his first visit to Darwin, at his beautiful home in Kent (in the year 1873), he found Sir Joseph Hooker there, and they had been employed the whole of that Sunday forenoon making experiments upon these vegetable secretions, with the grand result that they had discovered or demonstrated that this solvent was the exact analogue of the gastric juice in animals, and that the insect food passed through practically the same process of digestion and assimilation. The results of this investigation, and of the subsequent series of experiments on living and growing plants by feeding them systematically on particles of raw flesh, are fully stated in Darwin's famous work on the subject.

Mr. Cohen exhibited a specimen of the leaf-insect from Fiji.

Sir J. Hector exhibited a minute insect taken from a Spanish chestnut tree which it had destroyed. Mr. Bright had sent it from Greytown.

Mr. Hudson thought it was indigenous. He had observed it boring in native trees; he had not fully examined them yet.

Mr. Maskell showed specimens supposed to be blights, but which he said were quite harmless.

Sir James Hector exhibited a trout which had been caught in the Wanganui River, near the Heads, by Mr. S. H. Drew, which, after examination, he considered to be a cross between the Loch Leven trout and a brown trout, and which had thereby acquired the characteristics of the Galway trout. Sir James Hector expressed the opinion that it was a pity the acclimatisation societies had put different kinds of trout in the same rivers, because crossed forms were sure to be the result, and no good specimens of fish would be obtained. He further stated that he had caught a Loch Leven trout in the Hutt River, and a fish which he believed was a true specimen of the Californian salmon.

Sir W. Buller presented the following pamphlets to the Society, which were laid on the table:—

1. "On the Sponge Remains in the Lower Tertiary Strata near Oamaru, Otago, New Zealand," by G. Jennings Hinde, Ph.D., and W. Murton Holmes. (Illustrated.)

2. "On the Occurrence of Two Species of *Cumacea* in New Zealand," by George M. Thomson, F.L.S. (with plates).

3. "Colenso's New Zealand *Hepaticæ*," revised by F. Stephani (with plates).

EIGHTH MEETING: *18th January, 1893.*

Sir Walter Buller, President, in the chair.

Papers.—1. "On Rainbows caused by Reflection in Still Water, and on Elliptical Rainbows," by Major-General Schaw, C.B., R.E. (*Transactions*, p. 450.)

Sir James Hector said that this was a most interesting paper. Few persons would imagine that there was so much to be learned on the subject of rainbows, and there was much in the paper that was quite new and had not been previously observed.

Mr. Harding was glad he had brought the subject forward at a previous meeting, as it had had the effect of bringing out such an admirable paper as General Schaw's; and he was glad to receive confirmation of his view that a reflected rainbow could be seen, although not the one visible to the eye. He hardly thought that the tertiary bow was accounted for in the paper.

Mr. C. Tanner referred to experiments he had made with a garden-hose, which gave complete circular bows.

Mr. Maskell was pleased that his question at the last meeting as to whether a rainbow could be reflected in the water had been the means of producing such an excellent paper as they had just listened to. It was evident that the painter he referred to had made a mistake in his drawing, for it was clear to him now that the reflection of *a* bow could be seen, but not that of *the* actual bow observed.

Mr. Richardson said there was a gentleman now in the room who had seen the reflection of a rainbow, and he would no doubt give a description of it.

Mr. A. Koch then said that on the 29th June last, about 10 a.m., on board the cable-steamer "Terranora," anchored off the pilot-station, in Worser Bay, his attention was excited by a very brilliant rainbow, forming a complete semicircle. It started about the back of the pilot-house, and continued its direction above the Pinnacle Rock, descending into the sea about half a mile from the eastern shore of the entrance to Wellington Harbour. The sea was without a ripple, a steady rain falling, and both sea and distant headlands of a deep slate-colour. The rainbow left a distinct and brilliant-coloured reflection upon the sea; and, having called the attention of some other gentlemen on board, an additional fact was observed, which none of us could explain—viz., that the reflection did not commence at the point at which the rainbow dipped into the sea, but started about 10 chains inside the semicircle formed by the rainbow. As doubts had been expressed on rainbow reflections, he was glad he had sketched this one (see Pl. LI.).

Sir Walter Buller said that, inasmuch as the rainbow appearance was due to the angle of incidence, and was governed by the laws of optics, it seemed to him that, technically, no two persons looking at the same time, but necessarily at different angles of vision, could see the same rainbow, so that, in truth, each pair of eyes had its own rainbow. He had seen perfect lunar rainbows, either colourless or with an extremely faint tint. The most remarkable one he had seen was at the Chatham Islands in 1855, and, if he could trust his memory, it was attended by a very pale secondary bow. The most beautiful solar rainbow he had ever seen was one projected on the cloud of fine spray at the Falls of Niagara in 1874.

Mr. G. Beetham had more than once seen a true lunar rainbow in New Zealand suffused with a pale colour like a faded solar rainbow.

Major-General Schaw said that the tertiary bow was formed by the third reflection. It was not often seen. He also said that the observation by Mr. Koch of a reflected rainbow was extremely interesting, as it

was the only instance of such a reflection having been seen that he had yet met with.

2. "Further Coccid Notes; with Descriptions of New Species from Australia, India, Sandwich Islands, Demerara, and South Pacific," by W. M. Maskell. (*Transactions*, p. 201.)

Before referring to his paper Mr. Maskell exhibited a small green beetle, and a fly which eats these destructive beetles. It was collected by Mr. Pine, of Hastings. The fly is *Asilus lascus*, and probably was what is known as the bot-fly, and if it destroyed these beetle pests it would not be considered to be so harmful as a horse-pest.

Mr. Laing said that the bot-fly had been identified as an introduced Mexican fly.

Sir Walter Buller thought he recognised the fly exhibited as a native species with which he had been familiar for over thirty years. The native fly to which he referred was a predatory species, and common in certain parts. As to its supposed usefulness in eradicating the little green beetle, by preying upon it, this seemed quite absurd. As country people were aware, this little beetle with shining green surface came at certain seasons in countless millions, covering the manuka scrub (*Leptospermum scoparium*) so thickly that not a leaf was visible. On these occasions the Maoris went out and collected the beetles in baskets by shaking the scrub, after which they prepared them for food, finally drying them in the sun, and pounding them into a kind of bread. The speaker said that it must be satisfactory to members to find that one of their number had come to be regarded as a specialist in regard to this particular group of insects, all over the world. From all countries Mr. Maskell now received specimens for discrimination and description, and in the voluminous paper which he had now produced there was scarcely any mention made of a single New Zealand species. To a layman it ought to be sufficient proof that good work was being done when an investigator in New Zealand was accepted as an authority in America and Europe, and his assistance invoked in the determination of foreign species belonging to the family which he had made his special study; and, although the descriptions might seem dry and technical, there could be no doubt that such contributions added much to the scientific value of our annual volume of Transactions.

Sir James Hector said that Mr. Maskell's work was most valuable. He said he expected shortly to receive from America a beetle that would destroy the snail that was now doing so much damage. There were many other pests that required prompt attention.

Sir Walter Buller said that the best enemy to snails was the woodhen.

3. "On Heterostyled Trimorphism in New Zealand Fuchsias, with Notes on the Characters of the Species," by T. Kirk, F.L.S. (*Transactions*, p. 261.)

4. Sir J. Hector exhibited—(1) a sample of an unusual form of guano from the islands (exact locality not stated). It contains about 40 per cent. of broken and entire marine shells, cemented together in blocks by carbonate of lime, and 41·88 per cent. of tri-calcic phosphate. It should prove a very useful manure when ground to the same degree of fineness as the samples exhibited.

(2) A sample of supersulphate of soda, a salt which has only lately been introduced as a commercial article, was exhibited. It is a most singular compound, and will prove a very useful one for the cheap preparation of superphosphates from bones and guanos. As received it was in the solid state, but had liquified in part, owing to its having absorbed water from the air. It contained nearly 70 per cent. of sulphuric acid: 15 per cent. (that is, on the specimen) is united with soda *strongly*, to form the sulphate; the other part, 54 per cent. on the salt, is so loosely combined with this alkali that it is available for the substitution of the free acid for preparing superphosphates. This salt contains from four to five times the quantity of sulphuric acid that is required to make the common sulphate (monosulphate) of soda, and two or three times that required by the bisulphate of soda. About half its weight is available sulphuric acid.

5. Sir J. Hector exhibited the flower of a plant *Strelitzia*, from the Cape of Good Hope; grown in McNab's garden; flowered after being planted twenty years. An oil-painting of the flower by Mrs. L. Stowe was also exhibited.

Annual Meeting: *15th February, 1893.*

Sir Walter Buller, President, in the chair.

New Member.—Mr. Robert Murdoch.

Abstract of Annual Report.

During the past year nine general meetings were held, at which thirty papers were read and discussed, and, besides these, several interesting objects were exhibited at the meetings by Sir James Hector, Sir Walter Buller, Mr. Maskell, Mr. Hudson, and other members, and brief descriptions given.

The attendance at the meetings was rather larger than usual.

Six new members have been added to the roll, and the total number is now 145.

With regard to the scheme of medal awards for meritorious papers, the Council is of opinion that it is desirable to modify the rule requiring that papers intended for competition be so marked by the authors, and that in future all papers read before the Society should be eligible.

The balance-sheet shows that the receipts for the year were £168 1s. 8d., and the expenditure £106 9s. 2d., leaving a balance in hand of £61 12s. 6d. There is also a sum of £21 18s. lodged in the bank at interest, which increases the credit balance to £83 11s. 4d.

Resolutions, confirming recommendations made by the Council, were passed as follows:—

1. That, in regard to the scheme of medal awards, it is desirable to modify the rule requiring that papers intended for competition be so marked, and that in future all papers read before the Society be eligible. In awarding the medals for the papers the judges are empowered to take

into consideration the work previously done by the authors. 2. That, in connection with the intended purchase of books, members be invited to send in to the Secretary lists of books they think should be ordered, the Council to make use of such lists in their selection.

Sir James Hector, in moving a vote of thanks to the retiring President (Sir Walter Buller), said that the best thanks of the Society were due to Sir Walter for the assiduity, zeal, and punctuality with which he had attended to the affairs of the Society during the past year. At all times ready to assist with his special knowledge and experience, he had shown the keenest interest in the welfare of the Society. Of late he had attended and presided over the meetings at much personal inconvenience, because he was busy with his arrangements for a visit to England, where, he felt sure, Sir Walter Buller's strong character and energy would be of great value to the colony, because he was now going Home to take part in a work of vast importance to all the colonies of the Empire—to assist in founding and elaborating the Imperial Institute.

In responding to the hearty vote of thanks which was accorded by the meeting, Sir Walter Buller said that, although he was removing himself for a time to the other side of the world, he hoped to keep himself in close touch with the colony, and in correspondence with the more active members of the Society over which he had enjoyed the privilege of presiding.

Election of Office-bearers for 1893.—*President*—Major-General Schaw, C.B., R.E.; *Vice-presidents*—G. V. Hudson, F.E.S., and S. Percy Smith, F.R.G.S.; *Council*—C. Hulke, F.C.S., W. M. Maskell, Sir J. Hector, K.C.M.G., F.R.S., E. Tregear, F.R.G.S., G. Denton, R. C. Harding, and W. T. L. Travers, F.L.S.; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Papers.—1. "Notes regarding the Icebergs seen at the Chatham Islands on the 28th October, 1892," by Mr. A. Shand. (*Transactions*, p. 516.)

Sir James Hector said that the stranding of icebergs on the Chatham Islands suggested very unusual meteorological conditions in antarctic regions. With a diagram he explained the usual limits of the drift ice, and how it occasionally was carried far north of the same latitude as the Chathams, but only east of the Cape of Good Hope and east of Cape Horn. Australia and New Zealand, with its outlying islands, formed a third promontory—although a submerged one—extending towards the antarctic ice-cap; but the sea to the eastward of this was very free from ice, and, indeed, the greatest extension of open sea towards the South Pole was in the longitude of New Zealand. From Mr. Shand's description, the Chatham Island bergs appear to have quite lost the table-topped form characteristic of Southern Sea bergs. They had probably floated for a long distance in temperate water, and had been several times overturned, and from their altitude they must have been submerged about 500 fathoms. Only deep currents, therefore, could have controlled their movements. The winds would exercise but little effect on them. They followed in a regular procession from E.S.E. This is contrary to the usual direction of currents, and suggested that these must have been altered by the shifting of the anticyclonic or high-pressure area of the South Pacific to an unusually high latitude, just as occurred when Captain Fairchild reported that the barometer read 30·8 during the time he was cruising off Antipodes Island. The effect of such a shift would be to establish easterly winds and currents where westerlies commonly prevailed, so that if, as had been reported, floating ice had been seen unusually

far north in the South Pacific some of it may have drifted westward along the northern side of the anticyclonic area. It might be conjectured that such unusual conditions of atmospheric pressure had excited actively the great southern volcanic mountains Erebus and Terror, and thus indirectly given rise to the sudden fluctuations of atmospheric conditions which had distinguished the present season. For instance, on Saturday last two marked atmospheric waves were recorded, at 4 a.m. and 11 a.m., similar to that which followed the Krakatoa eruptions of 1884. On Sunday morning (12th instant) the accumulated stresses on many fault-lines in New Zealand were liberated, giving rise to widely-felt earthquakes; and on Monday evening a remarkably abrupt atmospheric depression, with a violent gale, traversed New Zealand from south to north in a few hours. It might be worth following out the same idea with the view of ascertaining how far the extraordinary fluctuations in Australia, which had caused droughts to occur within a few hundred miles of districts where the most disastrous and unprecedented floods prevailed, might have arisen from such an unusual regurgitation of the ocean-currents as was suggested by the stranding of the icebergs on the Chathams.

Mr. Maskell had never heard the matter put in such plain language. There was every reason to suppose that Erebus and Terror had some connection with recent disturbances. It was strange that this theory had never occurred to any one before. He was not quite clear yet about the connection between earthquakes and atmospheric pressure. He had felt a number of earthquakes, but never any accompanied by a storm; it was always fine weather. It was quite a new view of the matter to account for earthquakes in New Zealand by disturbances far away.

General Schaw said that when a shock came the wind generally ceased, and then came on again. Moderate shakes might be felt in fine weather which would not be noticed in a storm.

Mr. Tanner was on the Rimutaka when the earthquake in question occurred, and he was surprised to feel it, as he had always thought that earthquakes were not felt on the hills; he quite expected that Wellington had been wrecked. On the following night there was a severe storm, but whether it had any connection with the earthquake he did not know.

Sir Walter Buller was in Auckland when the great earthquake of 1855 occurred, and since then had felt hundreds of shocks, but, as far as he remembered, none had taken place in bad weather.

Mr. Hulke had felt earthquakes with a low barometer and bad weather. There was no doubt that disturbances at long distances did affect us here.

Sir James Hector said it was not the good or bad weather that produced earthquakes, but differential weather—the difference of pressure when the strain was taken off—that was the time to expect shakes. The difference of 2in. in the barometer between New Zealand and Australia in 1868 caused great disturbances. (See vol. xiv., p. 536.)

2. "On a Curious Property of Odd Numbers," by T. B. Harding; communicated by R. C. Harding.

The writer, referring to the well-known proposition of Euclid, that in every right-angled triangle the sum of the squares of the base and the perpendicular is equal to the square of the hypotenuse, and the familiar example of the right-angled triangle the sides of which respectively equal 3, 4, and 5, added, "It is not, I think, so generally known that what is here true of the number 3, the perpendicular of the triangle under consideration, is also true of the whole series of odd numbers." Dividing the square of this number, 9, into two parts, differing by unity (4 and 5), we have the base and hypotenuse. Similarly dividing the square of 5 into 13 and 12, of 7 into 25 and 24, and so on through

the whole series of odd numbers, a right-angled triangle would be the result. From which he deduced the curious fact that, if the length of one side of a triangle be an odd number, and the square of this number be equal to the sum of the lengths of the other two sides, of which one is greater than the other by 1, the triangle is a right-angled triangle. The paper was illustrated by diagrams of several triangles of various proportions, and by a graphic solution of the geometrical problem involved.

Major-General Schaw said that the fact was curious and interesting, and, though it might not be new, was certainly not generally known. He did not think that it would have any practical value in triangles the perpendicular of which exceeded 7. Even in the case of the latter number the triangle became very "ill-conditioned," the angle opposite to the perpendicular being very acute, and therefore difficult to fix accurately.

3. "The Moas and the Moa-hunters," by M. A. de Quatrefages; translated by Laura Buller. Communicated by Sir W. Buller. (*Transactions*, p. 17.)

4. "On the Nature of Stinkstone (Anthraconite)," by W. Skey. (*Transactions*, p. 379.)

5. "Further Results obtained in support of my Theory as to the Oxidation of Gold in presence of Air and Water," by W. Skey. (*Transactions*, p. 381.)

AUCKLAND INSTITUTE.

First Meeting: *13th June, 1892.*

Professor F. D. Brown, President, in the chair.

New Members.—R. Garlick, J. W. Lusher, H. Shrewsbury, G. W. Wright.

The Secretary read a list of donations to the Library and Museum received since the last meeting.

The President delivered the anniversary address. He said that on the two previous occasions when the members had honoured him by placing him in the responsible position of President he had thought it his duty to say something respecting the enlargement of the Museum and its position generally. But now that an important addition to the building was nearly completed, it was no longer necessary to say anything on that subject, except in the way of congratulating the members on the improved prospects of both Museum and Institute. He then drew attention to a letter recently received from the Minister of Lands, intimating that, in response to the representations of the Institute, the Government would endeavour to purchase the Little Barrier Island as a preserve for native birds. The satisfaction he derived from that letter, however, was to a certain extent diminished by the knowledge that at the present time the timber growing on the island was being rapidly cut down, and the birds destroyed; so that, unless the action taken by the Government was speedy, it would not be of much avail. After these preliminary remarks he went on to speak of those recent discoveries respecting the nature and constitution of ether which render it probable that photographs may be taken in colours, and electrical signals made without the aid of wires, illustrating his remarks with diagrams and specially-constructed apparatus.

Mr. Peacock proposed a vote of thanks to Professor Brown for his able address. He had succeeded in interesting all present in the subject he had selected, and his lucid and thorough explanations of many obscure points were specially valuable.

The motion was seconded by Dr. Purchas, and carried unanimously.

Second Meeting: *27th June, 1892.*

Professor F. D. Brown, President, in the chair.

New Member.—E. W. Payton.

Papers.—1. "On the Occurrence of Granite and Gneissic Rocks in the King-country," by James Park, F.G.S. (*Transactions*, p. 353.)

2. "Evolutionary Ethics," by the Rev. J. Bates.

The Chairman said they would all agree with him that the paper was a very valuable one, and no doubt some of the members would like

to say something on it. The question of teaching morality in the public schools was one which must press itself on their attention throughout Australasia.

Dr. Bakewell said he had been a member of this Institute for the last seventeen or eighteen years, and he must say that this paper read by Mr. Bates was a new departure, and brought them to a higher plane. He must congratulate Mr. Bates on opening up this inquiry with a paper which was so crammed with valuable and much original thought. In fact, the reasoning was too close to allow them to take it all in; but he quite agreed with Mr. Bates's ideas of the system of teaching morality in the State schools. They had got rid of religion and of morality as a subject of education. On visiting the French war-ship "Dubourdieu" recently, he observed "Amor patriæ" painted on the poop and on different parts of the ship. That kept constantly before the officers' and sailors' minds their duty of patriotism; and if they brought before the minds of their youths certain systems of morality they would never lose them. He was aware that copybook morality was often ridiculed, but he held that maxims imprinted on the memory in early youth were never lost. There was a higher system of morality than that propounded here, and if it was taught in the public schools it would make a great effect on the rising generation. Their young people were growing up without a code of ethics; they did not go to church, and they heard no system of morality from their parents. The French were going to work the right way, and something of the kind it was necessary to adopt here. He briefly criticized some points in the paper, but concluded by congratulating Mr. Bates for his excellent and thoughtful paper.

Mr Josiah Martin agreed with Dr. Bakewell that it was impossible to follow in one night the chain of argument and thought contained in the paper read by the Rev. Mr. Bates on one of the most important subjects that could be brought forward. He was obliged to him for opening a subject which would form matter for many evenings' discussion, and he would like that it should be held over, as he might be able to add some personal observations on the subject.

The Rev. Mr. Campbell also spoke in the same direction, warmly eulogizing the author.

Mr. Thomas Peacock also agreed as to the value of the paper, but thought it would be better discussed after consideration. He did not agree with a statement made by one of the speakers that the teaching in their public schools was void of morality, for a glance at the school-books would show differently. They contained lessons of high morality, and it was not correct to say that morality was banished from their schools. The paper, however, was a most valuable one, and well deserved consideration.

Third Meeting: *11th July, 1892.*

Professor F. D. Brown, President, in the chair.

Professor C. A. Pond delivered a popular lecture on "The Aryans in their Primitive Home."

Fourth Meeting: *25th July, 1892.*

Professor F. D. Brown, President, in the chair.

New Member.—Dr. Humphry Haines.

Papers.—1. Discussion was invited on the paper read by

the Rev. J. Bates on "Evolutionary Ethics" at a recent meeting.

Mr. Josiah Martin said that since the last meeting he had had an opportunity of going through the paper. It was full of facts, and was well worthy of consideration. He would not attempt to reply to it, but simply add something to it. He reviewed the leading points of the paper, and the theories set out by Mr. Bates. He especially referred to its bearing on moral teaching. He said that their public schools were doing noble work in inculcating obedience, order, patience, and perseverance, as well as truth, honour, and honesty; and he commented at some length on school-life in the school and playground, and the example set by the teachers. But there were, he admitted, weak points in the system, and the pupils failed to find that virtue was its own reward, for smartness passed for industry, and examinations for education, and there was a danger of liberty becoming license. They wanted the school system to teach responsibility and accountability, which was almost lost sight of now that the dogmas of Scripture were not taught in their schools. To counteract that, they should support the authority of the teachers and attract the best men, for no text-book could have the power the example of the teachers had in making the characters of their future men and women. He held that the State should teach reverence for authority and the duties of citizenship, and should teach that privileges have their corresponding obligations, and that good conduct should be a qualification for every stage of advancement. Then, the instruction should inculcate loyalty and patriotism, and to accomplish this they must teach the secret of organization, which required the teaching of discipline and moral science. Many cried out with fear and alarm when the Bible ceased to be a text-book, and exclaimed that the schools would become godless. There never was a danger of that; but they wanted something to replace it, and such a text-book had not been yet written. Another subject of study should be social economy. Science and religion were not opposed, but went hand in hand in the advancement of the human race.

2. "Notice of the Occurrence of the Luth, or Leathery Turtle, on the Coasts of New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 108.)

3. Professor Brown exhibited a new wave-machine, which he had devised for showing the mode of propagation of the waves of light through the ether, and for explaining the interference of waves.

4. "Some Peculiarities of the Maori Language," by F. D. Fenton.

FIFTH MEETING: *22nd August, 1892.*

Professor F. D. Brown, President, in the chair.

Papers.—1. "The Effect of the Introduction of Deer on the New Zealand Bush: A Plea for the Protection of our Forest Reserves," by the Rev. P. Walsh. (*Transactions*, p. 435.)

The President stated that his sympathies were entirely in the direction of Mr. Walsh's paper. Nevertheless, it was difficult to arrive at any practical scheme for the thorough preservation of forest reserves. It was clearly impossible to fence a huge reserve like that surrounding Mount Egmont, and thus prevent the access of cattle; and yet the slow and

gradual depredations of cattle would in a few years greatly alter the character of that reserve. People visiting the forest would also by degrees destroy its sylvan character, for it seemed to be impossible to prevent such people from lighting fires and burning considerable areas. He regarded the destruction of the New Zealand forests as almost inevitable.

2. Exhibition of a model geyser, designed by Mr. C. Malfroy. This was an ingenious model, differing in several respects from those generally employed to explain the mode of action of a geyser. In the absence of Mr. Malfroy, it was exhibited by Mr. Josiah Martin, who also explained its construction and mode of working.

Sixth Meeting: *5th September, 1892.*

Professor F. D. Brown, President, in the chair.

Judge T. H. Smith gave a popular lecture on "Maori Nomenclature: Names of Persons, Places, and Things." (*Transactions*, p. 395.)

Seventh Meeting: *19th September, 1892.*

Professor F. D. Brown, President, in the chair.

New Members.—J. R. Reed and W. Seddon.

Professor A. P. Thomas gave a popular lecture, entitled "An Army of Defenders: An Account of Metchnikoff's Discoveries concerning the Power of Resistance against Disease."

Eighth Meeting: *3rd October, 1892.*

Professor F. D. Brown, President, in the chair.

Mr. E. Withy gave a popular lecture on "Sanitation and Ventilation as required in a Modern House." (*Transactions*, p. 459.)

Ninth Meeting: *17th October, 1892.*

Professor F. D. Brown, President, in the chair

New Members.—F. W. Maclean, G. Mueller.

Papers.—1. "New Species of *Araneæ*," by A. T. Urquhart. (*Transactions*, p. 165.)

2. "New Species of Coleoptera," by Captain T. Broun.

3. "On a Gigantic Sun-fish stranded near Gisborne," by Archdeacon W. L. Williams. (*Transactions*, p. 110.)

4. "The Causes of Fire on Shipboard," by J. C. Firth. (*Transactions*, p. 385.)

Annual General Meeting: *20th February, 1893.*

Mr. T. Peacock in the chair.

Abstract of Annual Report.

The number of members on the register is 187. Fifteen new members were elected during the year, and 23 names withdrawn, of which 3 were from death and 7 from resignation. In keeping up a Museum for the instruction and amusement of the public, the Institute is performing a work which, in other parts of New Zealand, and in Australia, is solely made a charge upon the public funds. The Council therefore feel that the Institute deserves more support from those who are able to afford it, and trust that the present members will use their influence to introduce new subscribers

The balance-sheets appended to the report give full information respecting the financial position of the society, but a brief synopsis will doubtless be useful to the members. The total income credited to the General Account has been £2,305 13s. 9d., but this includes a sum of £1,500 withdrawn from investment to meet the cost of the new addition to the Museum, so that the ordinary income may be stated at £805 13s. 9d. Last year the amount was £736 10s. 7d. The interest on the invested funds of the Costley bequest has been £482 5s., and the Museum endowment has yielded in rents and interest £162 11s. 9d. The members' subscriptions amount to £133 7s., a sum slightly under that realised last year. The total expenditure has been £2,295 15s. 9d.; but, as in the case of the income, this sum should be divided into two portions—one representing the ordinary expenditure incurred in the maintenance of the Institute and Museum, amounting to £763 2s., the other the cost of the new hall and its fittings, equalling £1,532 3s. 9d. Part of this, it will be remembered, was shown on last year's balance-sheet as an overdraft at the bank. The position of the invested funds of the Institute may be regarded as satisfactory. The total amount at the present time is £11,370 10s. 10d. As previously stated, £1,500 has been withdrawn during the year; but, on the other hand, £1,418 1s. has been added, so that the reduction since the last annual meeting is very small indeed. The Council consider that the members are to be congratulated on the fact that, notwithstanding the large cost of the new building, every liability in connection with it has been discharged, and that yet the capital of the Institute barely shows an appreciable reduction.

Nine meetings have been held during the year, at which sixteen papers were read.

The number of visitors to the Museum has largely increased during the year. On Sunday afternoons a register has been kept by the janitor, showing that 10,528 persons have entered the building on that day, being an average of 202 for each Sunday. On week-days the visitors have been occasionally counted, and, although an accurate estimate cannot be given, it is believed that the average attendance has been about 110. Excluding certain days on which the Museum was closed for cleaning, &c., this would give an attendance of 32,780 on week-days, or a total of 43,308 for the year.

In last year's report the Council fully stated the reasons that had induced them to enlarge the Museum. As the addition is now completed and opened to the public, it is desirable to give the members some information respecting its construction and cost, and the use to which it has been applied. It consists of a hall, 100ft. in length by 50ft. in breadth, placed on the south side of the main building, and at right angles to it. It is substantially built of brick, with concrete floor, and is roofed with iron and glass, being practically fireproof. The total expenditure in connection with the building was £1,532 13s. 9d., inclusive of the show-cases

and erection of the Maori house, together with the expenses incurred in suitably mounting and labelling the exhibits.

The new hall has been devoted to the ethnological collections, and particularly to that part illustrating the habits and mode of life of the Maori race, now by far the most complete in the colony. The collection is now arranged on a systematic and definite plan. The building was opened by a *conversazione* held on the 29th October. The Council have to thank His Excellency the Earl of Glasgow for presiding.

A considerable number of additions and donations have been received during the year.

The thanks of the Institute are due to Messrs. W. K. Graham and Co. and Mr. Hugh Craig for serving as agents of the Institute in London and San Francisco.

Election of Officers for 1893.—*President*—Professor Pond; *Vice-presidents*—Professor F. D. Brown, F.C.S., J. Stewart, C.E.; *Council*—W. Berry, C. Cooper, G. Mueller, T. Peacock, J. A. Pond, F.C.S., Rev. A. G. Purchas, M.R.C.S.E., E. Roberton, M.D., T. H. Smith, Professor A. P. W. Thomas, F.L.S., J. H. Upton, E. Withy; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S., F.R.S.; *Auditor*—W. Gorrie.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting: *5th May, 1892.*

W. H. Symes, M.D., Vice-president, in the chair.

Paper.—"A Criticism of Dr. H. von Jhering's Paper 'On the Ancient Relations between New Zealand and South America,'" by Dr. Karl Müller, of Halle; translated by H. Suter, and communicated by Professor F. W. Hutton. (*Transactions*, p. 428.)

The conclusions of the paper were adversely criticized by Professor Hutton, who pointed out that belief in the simultaneous origin of a species in different parts of the world was not at all in accordance with modern biological ideas.

Second Meeting: *2nd June, 1892.*

H. R. Webb, F.R.M.S., Vice-president, in the chair.

New Members.—Y. Donald, E. Beardsley, J. M. Madden, R. Donovan, D. Templeton-Clark, W. Bryce Wilkin, F. C. B. Bishop, J. Colledge, F. Knight Hunt, J. Beaumont, H. E. May.

Papers.—1. "On an Olivine-andesite of Banks Peninsula," by R. Speight, M.A., B.Sc. (*Transactions*, p. 367.)

2. "The Earthquake of the 4th December, 1891," by G. Hogben, M.A. (*Transactions*, p. 362.)

3. "An Enumeration of the *Janellidæ*," by C. Hedley; communicated by Professor F. W. Hutton. (*Transactions*, p. 156.)

Third Meeting: *15th June, 1892.*

W. H. Symes, M.D., Vice-president, in the chair.

This was a special meeting called for the purpose of altering the day of meeting. It was resolved, "That law xv. of the Institute be deleted, and the following inserted in its place: 'The ordinary meetings of the Institute shall be held monthly during the months of May to October, both inclusive, on such days as the Council may determine.'"

FOURTH MEETING: *6th July, 1892.*

Professor Bickerton, President, in the chair.

New Members.—C. E. Adams and E. Rutherford.

Papers.—1. "On Hail," by Professor A. W. Bickerton, F.C.S.

2. "On the Equilibrium of Gaseous Cosmic Spheres," by Professor A. W. Bickerton, F.C.S.

FIFTH MEETING: *3rd August, 1892.*

New Members.—R. Malcolm, D. Latter, C. Lewis, A. P. Harper, and W. P. Evans, Ph.D.

Papers.—1. "On some Causes for the Low Temperature of Dissociation," by Professor A. W. Bickerton, F.C.S.

2. "On Methods of determining the Rate of Increase of the Attraction of Molecules, in Terms of their Diameter," by Professor A. W. Bickerton, F.C.S.

3. "On the Specific Heat of Solutions at Constant Volume," by Professor A. W. Bickerton, F.C.S.

SIXTH MEETING: *7th September, 1892.*

Professor Bickerton, President, in the chair.

Papers.—1. "On *Anomalopteryx antiqua*," by Professor F. W. Hutton. (*Transactions*, p. 14.)

2. "Remarks on the *Carabidæ* of New Zealand," by Captain T. Broun; communicated by Professor Hutton. (*Transactions*, p. 194.)

3. "Notes on a Proposed New Genus of New Zealand Mosses, together with a Description of Three New Species," by R. Brown. (*Transactions*, p. 285.)

SEVENTH MEETING: *5th October, 1892.*

Professor Bickerton, President, in the chair.

Papers.—1. "Further Notes on New Zealand Earthworms, with Observations on the known Aquatic Species," by W. W. Smith; communicated by R. M. Laing, B.Sc. (*Transactions*, p. 111.)

2. "Description of New Species of *Musci*," by T. W. Naylor Beckett, F.L.S. (*Transactions*, p. 289.)

ANNUAL MEETING: *2nd November, 1892.*

Professor Bickerton, President, in the chair.

New Member.—W. E. Burke.

Papers.—1. "Contributions to the Molluscan Fauna of New Zealand," by H. Suter; communicated by Professor F. W. Hutton. (*Transactions*, p. 147.)

2. "New Species of Moas," by Professor F. W. Hutton. (*Transactions*, p. 6.)

3. "On some Little-known New Zealand Mosses," by T. W. Naylor Beckett, F.L.S. (*Transactions*, p. 297.)

4. "Note on *Splachnidium rugosum*," by R. M. Laing, B.Sc. (*Transactions*, p. 288.)

5. "Notes on the Earthquakes of 1891–92," by G. Hogben, M.A.

6. "Notes on the New Zealand Species of *Andreæa*, together with Descriptions of some New Species," by R. Brown. (*Transactions*, p. 276.)

ABSTRACT OF ANNUAL REPORT.

During the year eight ordinary meetings were held, at which twenty papers were read, as follows: Zoology, 4; botany, 5; geology, 4; physical science, 3; chemistry, 1; miscellaneous, 3. There are twelve contributors this year as against seven last year. Sixteen new members have joined during the year, and only five have been struck off the list or have resigned. The number now on the roll is 76, as against 65 last year.

The special feature of the year has been the formation of a photographic section, which is now at work, with Mr. S. Page as Secretary.

The balance-sheet shows a total receipt of £66 3s., and a total expenditure of £32 15s. 11d., thus leaving a credit balance of £75 6s. 2d., including the amount carried over from last year, £41 19s. 1d.

ELECTION OF OFFICERS FOR 1893.—*President* — Professor A. W. Bickerton, F.C.S.; *Vice-presidents*—R. M. Laing, B.Sc., Dr. Thomas; *Secretary*—B. Bull, B.Sc.; *Treasurer*—J. T. Meeson, B.A.; *Council*—R. W. Fereday, F. Barkas, S. Page, R. Speight, B.Sc., W. H. Symes, M.D., H. R. Webb, F.R.M.S.

The annual address was delivered by the President, Professor A. W. Bickerton.

OTAGO INSTITUTE.

FIRST MEETING: *10th May, 1892.*

C. W. Adams, Esq., President, in the chair.

1. Professor T. J. Parker, F.R.S., read a paper "On the Presence of a Crest of Feathers in some Kinds of Moa." This paper was illustrated by a number of skulls of different species of moa, at least three species showing evidence of the feather-pits. (*Transactions*, p. 3.)

2. Professor Parker read a second paper, "On the Classification and Mutual Relations of the Moas," as deduced from the study of their skulls. (*Transactions*, p. 1.) A diagram was exhibited showing the grouping of the species.

A long and interesting discussion arose on these papers, Sir James Hector (who happened to be in Dunedin) addressing himself particularly to the distribution and possible causes of the extinction of the moa.*

* The following shorthand report of Sir J. Hector's remarks appeared in the *Otago Witness*:—

Sir James Hector said,—This is a subject in which I have always been deeply interested. For thirty years I have had more or less intimate relations with everything that has to do with the geology of New Zealand. One of the most important vistas in the geology of the country is that which it presents at the time preceding the occupation of the country by man. It is only by the study and marking-out of the natural life-history, and in that the history of the moa, that we can ever arrive at the features that New Zealand presented when man first arrived and took part in the natural economy of the country as a disturbing element. New Zealand must at that time have presented features of extraordinary interest, and it is a common opinion that no higher animal existed when man first appeared on the scene in New Zealand than moas, or, at any rate, birds. Whether the moas were the highest birds, or whether there were other birds higher, I am not going into that; but that bird forms were the highest forms of life before man was introduced is, from all that is known, clearly beyond a doubt. But the peculiar circumstance is this: that we had in New Zealand these wingless birds developed in immense profusion, and not only in profusion of form, but in profusion of numbers, and that to a degree that is not to be found in any other part of the globe. We have in other countries birds that have been deprived of the power of flight, for it is the distinctive attribute of these birds that they have been deprived of that power. But in other countries they have survived only in single individual species. Over the whole of Africa we have but one ostrich, over the whole of South America one rhea, and over the great bulk of the New Guinea islands one cassowary; yet in New Zealand we have crowded together, as if it were in the barnyard of a fowl-fancier,

3. Mr. Hamilton then read a paper on a fissure in limestone rocks recently explored by him, containing bones of re-

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such a variety of forms that it is impossible to understand it in any other way than that this was a kind of freak of Nature—a kind of artificial natural-selection process in progress—that is to say, that Nature, by its surroundings, produced the same variety of circumstances, the same definition in range, that a fowl-fancier would adopt in order to produce all the great varieties of fowls that we now find in a domestic state. And yet this must have been all done by Nature; because that this great number of varieties actually existed before the Maoris arrived in New Zealand is, I think, beyond all doubt, and the Maoris—the first-comers to these Islands—only completed the destruction that had already been in progress. Now, the formation of all these different species must have been, I think—and it is generally accepted that it must have been—the last event in the progress of a great geological epoch—the disappearance of a great continent, the sinking of a wave on the earth's surface. We must have had a continental area extending far to the eastward—there is evidence of that—embracing the Chatham Islands and far beyond; and that gradually this vast area of land, by the process of submergence, was so reduced that moas were driven back, and, instead of occupying great pampas, great fields for the development of the race, they were confined to a narrow mountain-range, intersected by steep ravines and great watercourses, and restricted by a narrow seaboard. Within that area natural selection, acting in these artificial restraints, soon produced all the varieties that we now find from one original stock. Whether Professor Parker in his most interesting remarks this evening has hit upon the derivative or not I am not qualified to give an opinion, but I think it must be allowed that all the moas must have been derived from one stock, and that that derivation must have taken place within New Zealand. There is no tendency of the ostrich to divide. We have never heard even of marked varieties, although its range is enormous, extending many degrees south and many degrees north of the equator, and east and west a number of degrees of longitude. But here on this narrow ridge we certainly have great variety of form produced, but, still, not more than we see produced from a single derivative in all the domestic poultry we have bred and developed. There is one point occurs to me. If that is really the case any classification that is going to prove correct in the long-run will, within the New Zealand area, tend to show the distribution of the moas. We will take the original type of moa, as any moa. The original moas that were imprisoned in any particular part of New Zealand, in a narrow valley or on a certain plain clothed with a certain class of vegetation, must in time, by inbreeding and other causes, have assumed a certain distinctive form or variety; in another part of the country the moa of the original type would develope another form or variety, and so on; and in that way we should, if this idea is a correct one, find our varieties of the moa—the really correct varieties of moas, from their distinctive geographical distribution even within New Zealand. Up to the present time the only attempt that has been made has been one to distinguish between the moas of the South Island—the largest area of New Zealand—from those of the North Island. So far I do not think any other distinction has been made; but I think we shall require to go much more deeply and closely into the question if the real distribution of the moa is to be the test. That is a field which, so far as I know, is untouched; and I may say that the manner in which moa-bones hitherto have been collected, almost without exception, has not been at all favourable to getting exact data upon the subject. When a find of moa-bones is again made—and there are

cent and extinct birds, with a notice of the skull of *Harpagornis*, and some bones representing a new species of *Fulica*, for which

many places known to myself even where they could be found—it is to be hoped that the investigation will be made in a thoroughly scientific manner, and that many more facts will be ascertained as to the interment of the moas and the distribution of the birds than have been evolved in searches hitherto. The extinction of the race of moas seems to have been extraordinary. It must have been by a slow and gradual process To-day, when in the Museum, Mr. Hamilton called my attention to the diseased condition of some of the rib-bones of the moa specimens. Some years ago when I lived in Otago I noticed that as a rule all the moa-bones found in the North presented more or less symptoms of the diseased state of the original bird. There may have been active diseases at work destroying the moas. That is a cause of the destruction of the moa that I think has been rather overlooked, and there is distinct evidence from the examination of the skeletons that there has been some such process at work. Then, again, we have, of course, the destruction of the moas from other natural causes. In a country that I am familiar with—the prairies of North America—as you are all aware, the bison has become nearly extinct—almost absolutely extinct—though I remember that in about 1860 you could see thousands of them scouring over the prairies in all directions; but before that their number was even more abundant. The first thing that led to the destruction of the bisons was the existence of disease to an alarming extent. Nearly all the buffaloes and the deer in that country used to die by hundreds of thousands, and in certain seasons their bodies were heaped up in the river-courses till they became a perfect pestilence to the Indians—for there were no other inhabitants there then—and the devastation caused by that disease was something terrible. One could hardly attribute that disease to the presence of man. However, since then the buffaloes, without breaking up into many varieties or species or forms, have died completely, keeping the characteristics of their species to the very end, when they disappeared. This has not been so with the moas. The moas seemed to have struggled among themselves—to have accommodated their physical forms to their surroundings, to have undergone many changes; and I should suspect they suffered largely from disease in consequence. Then came the advent of man with his firestick. Probably in some parts of the North Island it did not want man's firestick—the fire came from other sources. With man's intervention, anyhow, fire must have done immense damage all over the country. In the interior of Otago we found in the early days heaps of moa-bones scattered over the surface, and if we digged we found them. Among the moa-bones found in the swamps were great masses of charred bones, showing the agent that had been at work in their destruction. Many, no doubt, were destroyed by fire; and I found in a triangular area alongside the Wakatipu Lake a place where they had evidently been penned in by the fire—stopped in by the scrub that covered the steep mountain on the one side and by the deep lake on the other side, and so, there being no escape, they had perished. When I found these skeletons they were lying as they had been left by the fire; and so all over the country fire must have exercised a very destructive effect, especially upon the eggs, for no eggs have been found anywhere excepting where they have been accidentally overlain by blown sand, as was the case with the famous eggs found at Cromwell, where we found an egg actually containing chick-bones under 3ft. of sand, on the left-hand side of the Molyneux River at its junction with the Kawarau River at Cromwell. In that instance the egg was embedded in the sand, and escaped. But for that one escape how many thousands must have been destroyed

the name of *Fulica prisca* was proposed. The specimens exhibited were all obtained from the fissure, and comprised two beautiful species of moa, two skulls and bones of *Notornis*, bones of *Harpagornis*, including many not previously found, and a series of the remains of the *Fulica*. Diagrams showing the shape and size of the fissure, and the mode in which the bones occurred, were shown. (*Transactions*, p. 88.)

New Member.—Miss Gordon Rich.

Second Meeting: *14th June, 1892*.

C. W. Adams, Esq., President, in the chair.

Dr. Belcher read a paper entitled "A Page of Latter-day Literature."

New Members.—Rev. J. T. Penfold, J. Smith (of Fernhill), A. Lee-Smith, Henry Williams.

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the moment the fire spread over the country! Then, we know with perfect certainty that the Maoris must have scoured the country. When they first arrived, and had increased to a sufficient number, and lost their terror of the wilderness, it is quite certain they must have enjoyed hunting the moas in all directions. It is of no use some Maori experts saying that, as the early Maori traditions do not contain much reference to the hunting of the moa, they could not have had much to do with its destruction. In point of fact, very little reference at all is made to the moa. But it should be remembered that the Maori experts collected the traditions almost entirely from the North Island, where probably, or possibly, the moa was extinct at a much earlier period than in the South Island. It is quite possible that the Maoris in the North Island who succeeded those who had hunted the moa may not have maintained this early tradition. In the South Island no attempt has been made, so far as I can learn, to collect the traditions from the Maoris. Still, we have the actual remains of the moa; and there is no doubt that people with exactly the same habits and customs and modes of living as the existing Maoris — not Maoris with weatherboard houses and buggies, but people the same as the Maoris were eighty years ago—actually used the moa's flesh and eggs for food. There is no doubt whatever about that; so that we ourselves have arrived at a period not very long subsequent in date to the final disappearance of the moa. It seems incredible to us that a race of birds so gigantic in size should disappear so rapidly; but it is not so incredible when we look at the fact that it is little more than a hundred years since the buffalo ranged right through the eastern parts of the United States, and yet that the traveller could not now gather the slightest fragment of the remains of buffalo in the eastern States of America, and that in a very few years even in the western prairies it will be impossible to collect any evidence of the former existence of the bison there, although, as I have already said, I have seen them there in thousands myself. I only make these remarks to show the great importance of the thorough and perfect investigation of this subject.—Ed.

THIRD MEETING: *12th July, 1892.*

C. W. Adams, Esq., President, in the chair.

1. The Secretary read a note by Mr. F. Sandager, of Moeraki, communicated by G. M. Thomson, F.L.S., "On Sea-trout at Moeraki." (*Transactions*, p. 254.)

In the discussion which followed, it was agreed that it was very desirable that specimens should be caught, so as to thoroughly identify the species.

2. The Secretary then read a paper by Dr. Von Jhering, communicated by G. M. Thomson, F.L.S., "On the Genus *Atax*, and the *Unionidæ* of New Zealand." (*Transactions*, p. 252.)

Professor Parker, in speaking on this paper, gave a short account of Dr. Von Jhering's paper in the last volume of the Transactions, in which a suggested reconstruction of land-areas in the Southern Hemisphere in Tertiary times is argued, and the regions defined. The Professor also pointed out the real importance of the subject of the note just read.

3. Professor Parker then made a short addition to his note read at the May meeting on the presence of a crest on the skull of some species of moa, stating that he had found similar pits or depressions in the skull of the green woodpecker, which corresponded with the bases of the feathers forming the erectile crest of that bird.

4. Mr. D. Pelin, M.A., F.L.S., then read a botanical paper, in which he described a genus of boraginaceous plants new to this country. Mr. Pelin exhibited several mounted specimens of this interesting plant, and of other species, either new or rare.

5. Mr. Hamilton then read a paper on some ancient Maori bone combs. (*Transactions*, p. 483.) The specimens described in the paper were exhibited by Mr. John White, of Anderson's Bay. Mr. White also showed two cards of bone relics.

New Members.—J. Armstrong, sen., F. Armstrong, Miss Annette Wilson, F. Jones, W. D. Milne, W. Cunningham Macgregor.

FOURTH MEETING: *11th August, 1892.*

C. W. Adams, Esq., President, in the chair.

1. Mr. D. Wilkinson read a paper on the volatilisation of silver, being the result of a series of experiments on the mode of treatment of the Puhipuhi silver-ores conducted at the Otago School of Mines.

2. Mr. Hamilton read a paper on recent researches in Easter Island, and summarised the information collected by

the American exploring party in the United States steamship "Mohican" as to the peculiar stone images and burial-platforms which exist in such great numbers on this small but interesting island.

3. Mr. F. Chapman gave some further notes on greenstone, and showed some photographs.

4. Dr. Scott exhibited a series of interesting models recently presented to the Medical School by Dr. Maunsell.

Fifth Meeting: *13th September, 1892.*

Dr. T. M. Hocken read another of his papers on the early history of New Zealand, continuing his description of the founding of the Canterbury Settlement.

Sixth Meeting: *11th October, 1892.*

C. W. Adams, Esq., President, in the chair.

1. Miss A. Wilson read a paper on the relations between colour and sound. (*Transactions*, p. 510.) The paper was fully illustrated by lantern-slides and instrumental and vocal music. In the discussion which followed, Dr. Belcher spoke on the general bearings of the subject.

2. Mr. D. Wilkinson then read a paper on aluminium, describing the latest modes of extracting the metal, and the various uses to which it is put. Specimens of the stages of manufacture which the ore (bauxite) goes through were exhibited.

3. Mr. Hamilton read a note on some very old Maori mats found in various parts of the interior of Otago, and on some Maori necklaces. (*Transactions*, pp. 486 and 491.)

New Members—G. A. Simmers, Dr. L. S. Barnett.

Annual Meeting: *8th November, 1892.*

C. W. Adams, Esq., President, in the chair.

The Secretary read the annual report, which stated that fifteen papers had been read before the society; that the library had been rearranged and cleaned, new book-shelves erected, and the catalogue brought up to date; a number of new books had been added by purchase, and the usual presentations and exchanges received

The report and balance-sheet were adopted.

The balance-sheet showed a total receipt for the year of £217 13s. 7d. (including a balance of £112 13s. 7d. brought forward), and a credit balance of £98 4s. 2d.; in addition to which, the statement of assets and liabilities showed a credit balance of £401 14s. 9d.

Election of Officers for 1893.—*President*—Dr. T. M. Hocken; *Vice-presidents*—C. W. Adams, E. Melland; *Treasurer*—Professor F. B. de M. Gibbons; *Secretary*—A. Hamilton; *Auditor*—D. Brent; *Council*—Rev. Dr. Belcher, Professor Scott, Professor Parker, G. M. Thomson, F. R. Chapman, D. Wilkinson, and G. A. Simmers.

The President then delivered an interesting address on some of the chief political features of the day.

Dr. Hocken was then installed as President for the next session.

New Member.—Dr. Truby King.

WESTLAND INSTITUTE.

Annual Meeting: *8th December, 1892.*

Abstract of Annual Report.

The report presented by the Trustees dealt exhaustively with the society's present position and future prospects, and was unanimously adopted. The financial statement showed a fair credit balance. The thanks of the society were unanimously awarded to the Borough Council for their liberal subsidy. The subscribers-roll contains sixty-eight names. The Trustees desire to convey their thanks to those proprietors who donate their papers to the reading-room. The revenue for the current year was £131 1s. 10d.; expenditure, £117 4s. 8d.; credit balance, £13 17s. 2d.

Election of Officers for 1893.—*President*—W. C. Fendall; *Vice-president*—A. H. King; *Hon. Treasurer*—H. L. Michel; *Committee*—Rev. J. Blackburne, Captain Bignell, Messrs. J. Churches, W. L. Fowler, T. H. Gill, Dr. Macandrew, A. Mahan, R. Ross, J. N. Smythe, J. Strauchon, R. W. Wade, and D. Macfarlane.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *9th May, 1892.*

Dr. Moore, Vice-president, in the chair.

Papers.—1. Inaugural Address by the Vice-president.

The subject of the address was "Microbes." The speaker dealt especially with the microbes of low fever and consumption, explaining their method of attack.

2. "Science in Cricket," by Mr. Neil Heath.

3. "Numismatics," by Mr. Lund, of Makatoka.

Specimens of Greek autonomous and Roman Republican coins were exhibited by Mr. Lund.

Second Meeting: *13th June, 1892.*

Mr. H. Hill, B.A., F.G.S., President, in the chair.

Mr. T. Humphries gave a very interesting account of the Waitomo Caves, illustrated by photographs by the aid of a magic lantern.

Third Meeting: *11th July, 1892.*

Mr. H. Hill, B.A., F.G.S., President, in the chair.

Papers.—1. "On Metre in Poetry," by Dr. Innes.

Dr. Innes illustrated his subject by reading extracts from the works of various poets, showing the different varieties of metre in use.

2. "On Submarine Telegraphy," by Mr. Cook.

3. "On Moa-remains in the Forest," by Taylor White. (*Transactions*, p. 504.)

4. "On the Wanganui Artesian Water-supply," by the President. (*Transactions*, p. 343.)

Fourth Meeting: *8th August, 1892.*

Mr. H. Hill, B.A., F.G.S., President, in the chair.

Papers.—1. "On After-images," by Miss Browning. (*Transactions*, p. 506.)

2. "On Weight," by Dr. Lucas, of Canada.

3. "On Coins" (second paper), by Mr. Lund.

The author dealt specially with Roman Imperial coins, twenty-two specimens of which were shown.

Fifth Meeting: *12th September, 1892.*

Mr. H. Hill, B.A., F.G.S., President, in the chair.

Papers.—1. "Bush Jottings," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 307.)

2. "On a Radiant Phenomenon," by the Rev. W. Colenso, F.R.S., F.L.S.

The author exhibited specimens of many plants, fungoids, and lichens.

Sixth Meeting: *10th October, 1892.*

Mr. Humphries in the chair.

Papers.—1. "On the Power of Attraction on the Earth's Surface," by Mr. Lessong.

The paper was illustrated by intricate calculations shown on the blackboard.

2. "On Coins" (third paper), by Mr. Lund.

British coins were the coins specially dealt with, twenty-two specimens of which were shown.

Seventh Meeting: *28th November, 1892.*

Papers.—1. "On the Native Dog of New Zealand; being a Rejoinder to Mr. Taylor White," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 495.)

2. "On the Effect produced by Current Electricity on Plant-growth," by Mr. McLeod. (*Transactions*, p. 479.)

3. "On the Native Dog of New Zealand" (continued), by Taylor White.

4. "On the Maori Dog and the Dog Philological," by Taylor White.

5. "Was the Original Dog of the Aryans of a White Colour?" by Taylor White.

6. "On Submarine Telegraph Cables," by Charles J. Cooke.

7. "On National Melodies," by Miss Morrison. (*Transactions*, p. 514.)

8. "A List of Fungi," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 338.)

9. "Phænogams: A Description of some Newly-discovered Indigenous Plants," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 324.)

10. "On Artesian Wells, Wanganui," by H. Hill, B.A., F.G.S. (*Transactions*, p. 348.)

11. "On Discovery of Artesian Water-supply, Ruataniwha Plain," by H. Hill, B.A., F.G.S. (*Transactions*, p. 350.)

12. "A List of *Hepaticæ*," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 341.)

13. "Cryptogams: A Description of a Few Lately-discovered Ferns, &c.," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 319.)

Dr. Moore described a visit lately paid by him to Ngauruhoe.

Abstract of Annual Report.

The report for the year ended 31st January, 1893, stated that seven ordinary meetings had been held, which were well attended, and at which twenty-nine papers had been read, as compared with fifteen in the previous year. The number of members on the roll is one hundred. The library has been much improved. The endeavour to obtain an endowment from the Government had failed. The Council say that they cannot let pass without notice the Rev. Mr. Colenso's offer of £200 to the Sir Donald McLean Memorial Fund Committee, on condition that the moneys collected for the purpose of providing a suitable memorial to the late Sir D. McLean be used towards building a museum to be called the "Sir Donald McLean Museum."

The balance-sheet showed the total receipts to have been £118 16s. 2d., and the expenditure £117 18s. 3d., while the overdraft had been reduced from £39 7s. to £11 10s. 2d., against which there are subscriptions outstanding to the amount of £23 2s.

NELSON PHILOSOPHICAL SOCIETY.

First Meeting: *28th March, 1892.*

Mr. A. S. Atkinson, Vice-president, in the chair.

The Right Rev. C. O. Mules, Bishop of Nelson, having been nominated, was duly elected to the Presidentship of the Society, rendered vacant by the resignation of our late esteemed President, Bishop Suter. He then took the chair.

The following resolution was passed:—

That this Society desires to express again its deep regret that the serious illness of its late President, Bishop Suter, has prevented him from continuing the many services he has rendered to the Society from its foundation, and, in recording its hearty thanks to him for those services, desires to repeat the strong hope it has before expressed, that he may be again restored to health and usefulness.

Exhibits.—A well-mounted collection of rare ferns.

Presentations to the Society.—An ancient Maori wooden bowl (described by the donor as a "blood-bowl"), by Mr. S. Skilton, of Anakaka; specimen of hybrid duck; skin of the rare bird *Apteryx haastii;* specimen of remarkable variation in the fern *Lomaria lanceolata;* a collection of ancient Maori implements found at Takaka, by Mr. R. I. Kingsley.

Papers.—1. "On a Hybrid Duck," by R. I. Kingsley. (*Transactions*, p. 107.)

2. "On a Specimen of *Apteryx haastii*," by R. I. Kingsley. (*Transactions*, p. 108.)

3. "Botanical Notes, Takaka District," by R. I. Kingsley. (*Transactions*, p. 304.)

4. "Description of the Discovery of Maori Implements at Takaka," by R. I. Kingsley. (*Transactions*, p. 494.)

5. "On a Remarkable Variation in *Lomaria lanceolata*," by R. I. Kingsley. (*Transactions*, p. 306.)

SECOND MEETING: *11th April, 1892.*

The Bishop of Nelson, President, in the chair.

Presentations to the Society.—A collection of fossils from Reefton. by Bishop Suter; an interesting specimen of fossil resin in limestone, by Mr. Hicks, of Motupipi.

Paper.—"Criticism on Mr. E. Tregear's Maori-Polynesian Comparative Dictionary" (Part I.), by A. S. Atkinson.

This was a most interesting paper, and a most animated discussion ensued.

THIRD MEETING: *16th May, 1892.*

Dr. L. Boor, Vice-president, in the chair.

Presentations to the Society.—A saddle shell, a fossil shell, two poisoned arrows, a traveller's water-bottle, a nose-flute, and an infant's sacred wrapping-cloth (all from the Fiji Islands), by Miss Martin, of Stoke.

Papers.—1 "On Islam," by the Rev. W. St. Clair Tisdall.

2. "Criticism on Mr. E. Tregear's Maori-Polynesian Comparative Dictionary" (Part II.), by A. S. Atkinson.

A letter was received from Mrs. Suter thanking the Society for the resolution passed at the meeting held 28th March regarding Bishop Suter, the late President of the Society.

ANNUAL MEETING: *12th December, 1892.*

The Bishop of Nelson, President, in the chair.

ABSTRACT OF ANNUAL REPORT.

The Hon. Secretary's report showed that during the session four general meetings have been held and five Council meetings. Eight original papers have been read, and considerable interest has been taken in the work of the Society during the past year.

The Hon. Curator's report showed that the specimens added to the Museum by presentation and purchases were valuable and numerous, and that the Museum was in a fairly good condition.

The Hon. Treasurer's report showed a credit balance of £16 17s. 4d.

The report of the Hon. Curator to the School of Mines bore striking testimony to the success attending his classes of boys in assaying and mineralogy; but, in consequence of the lack of interest shown by the adult portion of the community in the work, it was found impossible to meet expenses. It was therefore resolved to close the school.

ELECTION OF OFFICERS FOR 1893.—*President*—The Bishop of Nelson; *Vice-presidents*—Mr. A. S. Atkinson and Dr. L.

Boor; *Hon. Secretary*—Mr. Sidney Black; *Hon. Treasurer*—Dr. James Hudson; *Hon. Curator of the Museum*—Mr. R. I. Kingsley; *Hon. Custodian of the School of Mines*—Mr. Worley; *Council*—Drs. W. Mackie and G. H. Cressy, Messrs. J. Holloway, Kingsley, and Worley.

Exhibits.—Specimen of adder's-tongue fern (*Ophioglossum vulgatum*) from the Dun Mountain, by the Hon. Curator; specimen of *Gorgonia* or marine tree, and a collection of European beetles, by Mr. E. Lukins; a piece of meteorite and some gypsum crystals, by Mr. Worley.

Presentations to the Society.—Four specimens of fossils from Greymouth, by the President; a myriapod found alive in Wellington in a bunch of bananas, by the Hon. Curator.

Paper.—"Criticism on Mr. E. Tregear's Maori-Polynesian Comparative Dictionary" (Part III.), by A. S. Atkinson.

This finished a most able and interesting paper.

APPENDIX

METEOROLOGY.

Comparative Abstract for 1892 and Previous Years.

Stations.	Barometer at 9.30 a.m.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean. Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max Temp. in Sun's Rays.	Min Temp. on Grass	Mean Elastic Force of Vapour.	Mean Degree of Moisture (Saturation = 100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year	Maximum Velocity in Miles in any 24 hours, and Date.	Mean Amount (0 to 10).
Auckland...	30 074	1·160	60 2	12·4	41·5	143 0	30 0	0 430	81	41·331	177		...	5·7
Previous 28 years ...	29 986	..	59·1	...	. .	.		0 386	72	40·868	182			
Wellington	29 999	1·367	55·9	12·4	45·0	145·0	25 0	0 339	76	67·656	184	205	805 on 15th Oct.	4 6
Previous 28 years ...	29·926	.	54·7	...	. .	.		0 335	73	50·014	159			
Dunedin	29·871	1·457	51·2	13·4	46·0	136·0	26 0	0 279	73	47 552	160	139	530 on 12th May	5·4
Previous 28 years ...	29 988	.	50 2	.	...	.	..	0 277	73	34 590	159			

Average Temperature of Seasons, compared with those of the Previous Year.

Stations.	Spring. September, October, November.		Summer. December, January, February.		Autumn. March, April, May.		Winter. June, July, August	
	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.
Auckland	58·3	59 2	66·8	65 5	59 9	62 5	51·9	53 6
Wellington	55·0	55·3	61·5	61·7	59·4	57·4	46 5	49 3
Dunedin	52 8	51·4	57 3	56 8	50 9	51·7	42 0	44·7

GENERAL REMARKS FOR 1892.

JANUARY.—Generally fine in North, showory and unpleasant over centre, with strong winds and showery dull weather in South. Slight earthquake in South on 11th.

FEBRUARY.—Fine in North and over centre, but heavy rain in southern districts, causing floods. Earthquake over centre on 14th and 28th.

MARCH.—Weather fine in North, heavy rain during middle of month over centre, and showery during latter part in South; moderate winds. Slight earthquake on 17th over centre.

APRIL.—Tolerably fine in North, but showery weather over centre and in South, with southerly winds. A slight earthquake on 11th at Wellington at noon.

MAY.—On the whole showery weather, with prevailing southerly winds. Earthquake in South on 7th, slight.

JUNE.—Heavy rainfall throughout, and strong S.W. winds in North and over centre.

JULY.—Showery weather in North, with prevailing strong N.E. winds; over centre very heavy rainfall—the heaviest monthly record for twenty-eight years (12·165in.)—and strong southerly winds, and frequent hail, snow, and fog; tolerably fine, but changeable, in South. Earthquake on 8th over centre, slight.

AUGUST.—In North, showery and strong N.W. and N.E. gales, also heavy rain with strong N.W. winds over centre, and in South changeable but moderately fine weather. Earthquakes over centre on 1st, 14th, 19th, and 24th, slight; and in South, slight, on 23rd.

SEPTEMBER.—Finer weather in North, but frequent strong winds from N.E. and S.W.; showery unpleasant weather over centre, and showery in South. Earthquake on 25th over centre, slight.

OCTOBER.—Still showery weather generally, especially in earlier part of month, but on the whole finer than previous months. Earthquake on 13th over centre, slight.

NOVEMBER.—Still showery in North, with strong N.E. winds; much finer over centre and in South. Earthquake over central localities on 9th and 30th, slight.

DECEMBER.—Fine in North, and on the whole finer over central districts, although heavy rain during early part and strong N.W. winds; in South cold showery weather, with prevailing S.W. winds. Earthquake at Wellington on 2nd, slight.

EARTHQUAKES reported in NEW ZEALAND during 1892.

PLACE.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Gisborne	..	..	..	..	..	..	..	..	..	..	30*	1*	2
Tauranga	..	..	..	..	..	..	..	..	..	..	19*	..	1
Ormondville ..	..	..	..	..	..	..	..	..	..	11*	..	..	1
Woodville	..	14*	..	..	..	..	..	..	..	..	..	..	1
Palmerston North ..	..	14*	..	..	..	..	..	..	..	..	..	..	1
Marton	..	14*	..	..	..	..	..	..	..	..	..	..	1
Masterton	..	14*	..	..	27	..	..	..	..	..	..	..	2
Carterton	..	14*	..	..	..	..	..	..	..	..	..	..	1
Pahautanui ..	..	14*	..	..	..	..	..	..	..	..	..	..	1
Wellington .	..	14* 28	17	11	..	..	8	1, 14, 19, 24	25	13	9, 30	2	14
Havelock	..	..	..	..	..	..	..	24*	..	..	..	..	1
Nelson	..	..	..	..	..	..	..	24*	..	..	..	..	1
Blenheim	..	..	..	..	..	..	..	24*	..	..	..	..	1
Greymouth ..	..	..	..	..	..	..	..	24*	..	..	..	..	1
Westport	..	..	..	..	..	..	..	24*	..	..	..	..	1
Hokitika	..	..	..	..	..	..	..	..	..	..	..	27*	1
Christchurch ..	..	..	..	..	..	..	..	24	..	..	..	27*	2
Timaru	..	..	..	..	..	..	..	..	..	..	..	27*	1
Oamaru	..	..	..	..	..	..	..	..	..	8*	..	..	1
Dunedin	..	..	..	..	..	..	..	23	..	..	..	..	1

NOTE.—The figures denote the day of the month on which one or more shocks were felt. Those with the asterisk affixed were described as *smart*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. These tables are therefore not reliable as far as indicating the geographical distribution of the shocks.

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1873.

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1876.

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1877.

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1878.

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1883.

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1885.

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1888.

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1890.

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Wilson, W. S., Auckland
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Withy, E., Remuera*
Worthington, H., Auckland
Wright, G. W. ,,

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Murray-Aynsley, H. P.
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Bealey, S.
Beardsley, E.
Beaumont, J.
Beckett, T. W. Naylor, F.L.S.
Bickerton, Prof. A. W., F.C.S.
Binnsfield, Rev. J. N.
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Bishop, R. C.
Blakiston, C. R.
Booth, G. T.
Bowen, C. C.
Brown, R.
Bull, B., B.Sc.
Burke, W. E.
Chilton, C., B.Sc., F.L.S.*
Clark, D., Templeton
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Craig, D.
Cunningham, P.
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Evans, W. P., Ph.D.
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Gray, G., F.C.S.
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Harper, A. P.
Hewlings, S.
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Meyrick, E., B.A., F.E.S.
Mollet, T. A.
Monro, D. H.
Page, S.
Palmer, J.
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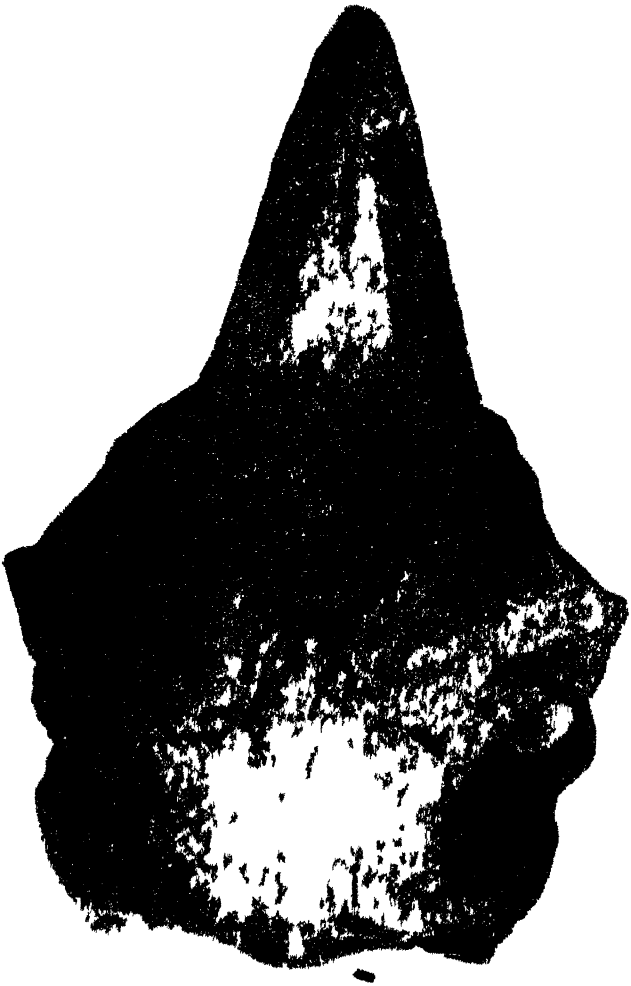
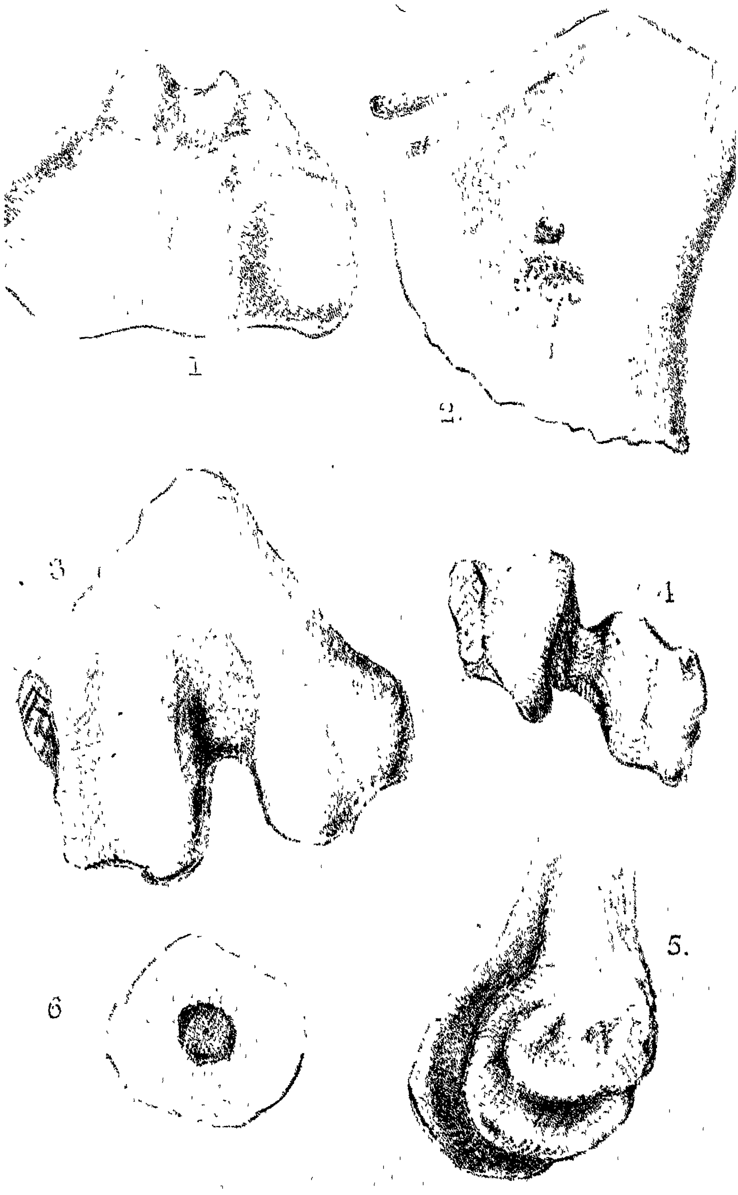


Mesopteryx sp b

Dinornis torosus

Anomalopteryx didiformis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To accompany Sir W. L. Buller's paper.

Fig. 1.

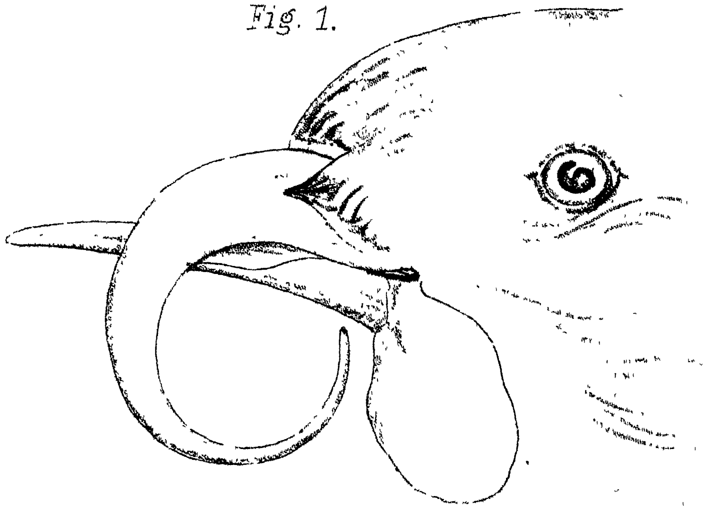
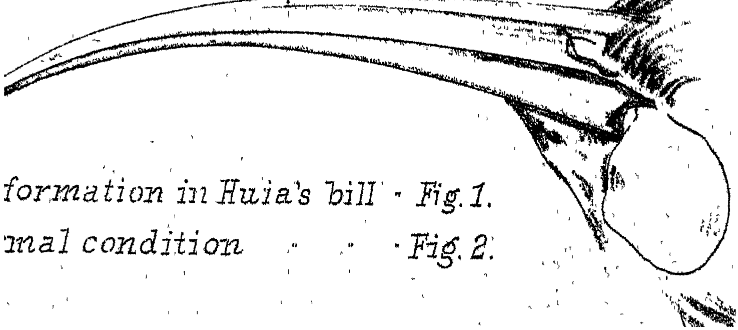
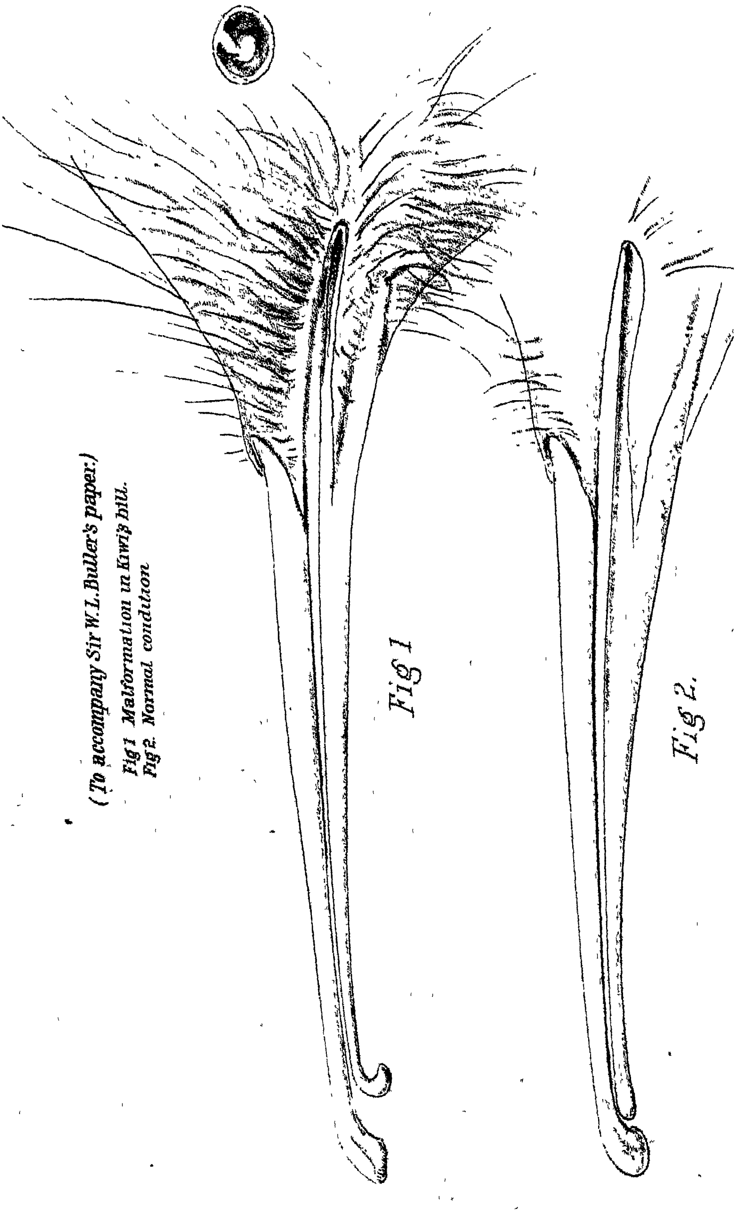


Fig. 2.



formation in Huia's bill . Fig. 1.
mal condition . . . Fig. 2.

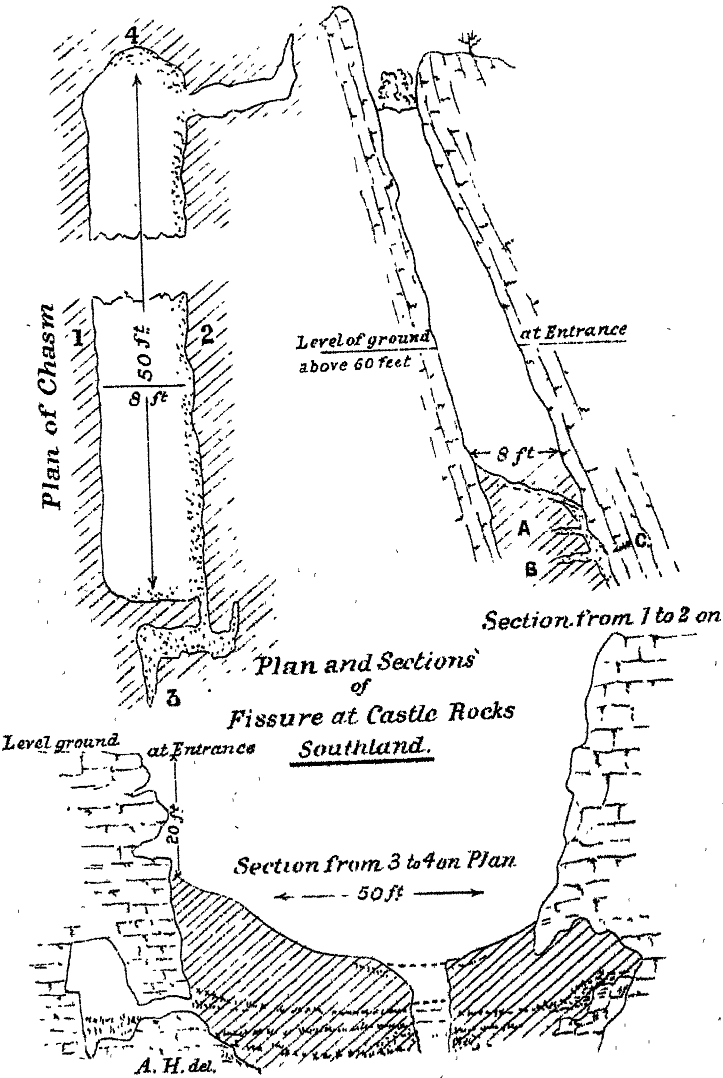


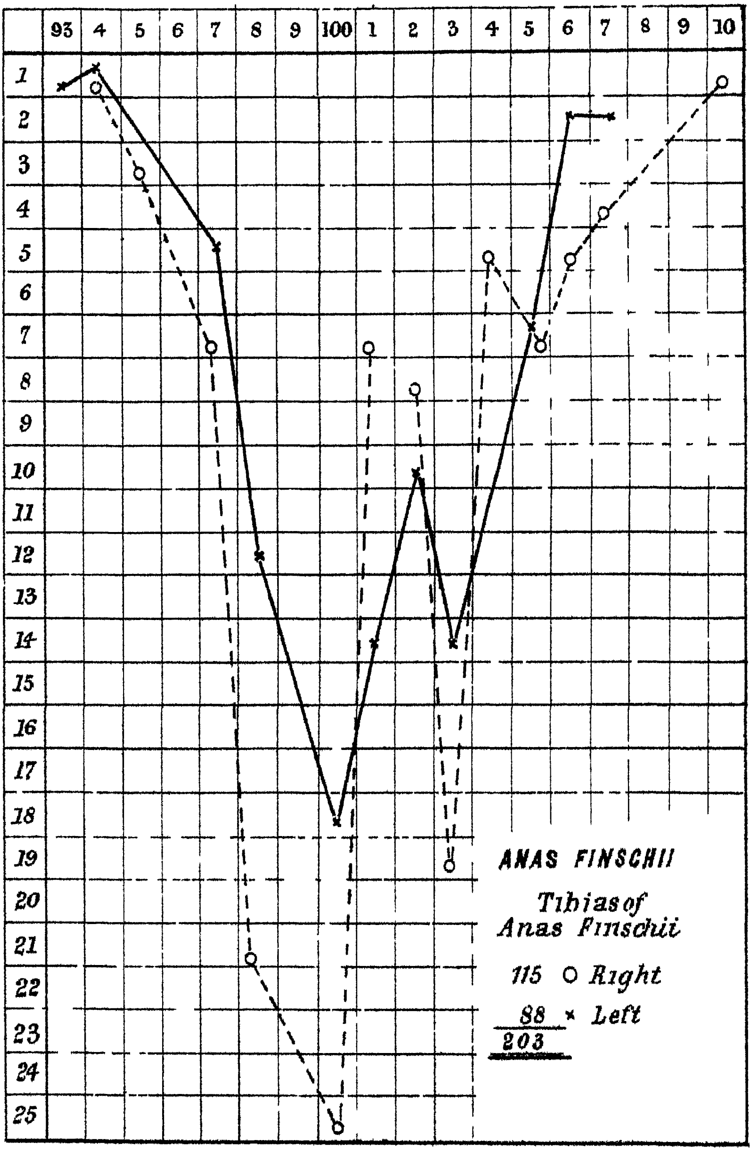
(To accompany Sir W. L. Buller's paper.)

Fig 1 Malformation in Kiwi's bill.
Fig 2. Normal condition

BONES IN FISSURE CAVES

To illustrate Paper by A. Hamilton.




ANAS FINSCHII
Tibias of Anas Finschii
115 O Right
88 × Left
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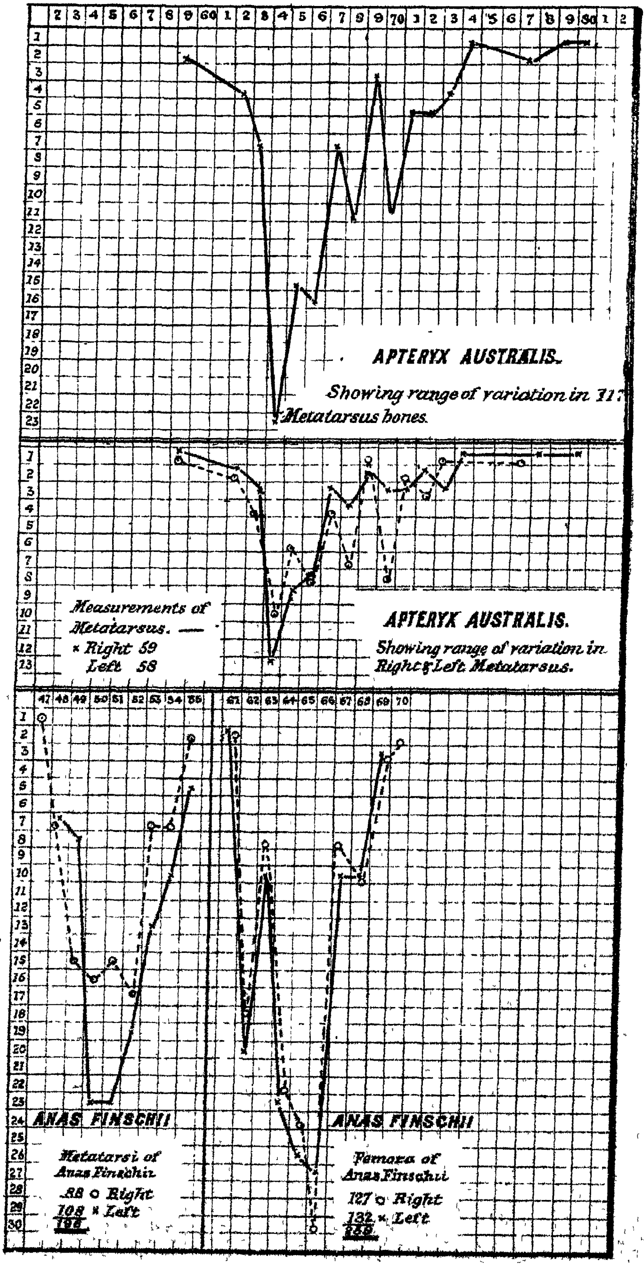
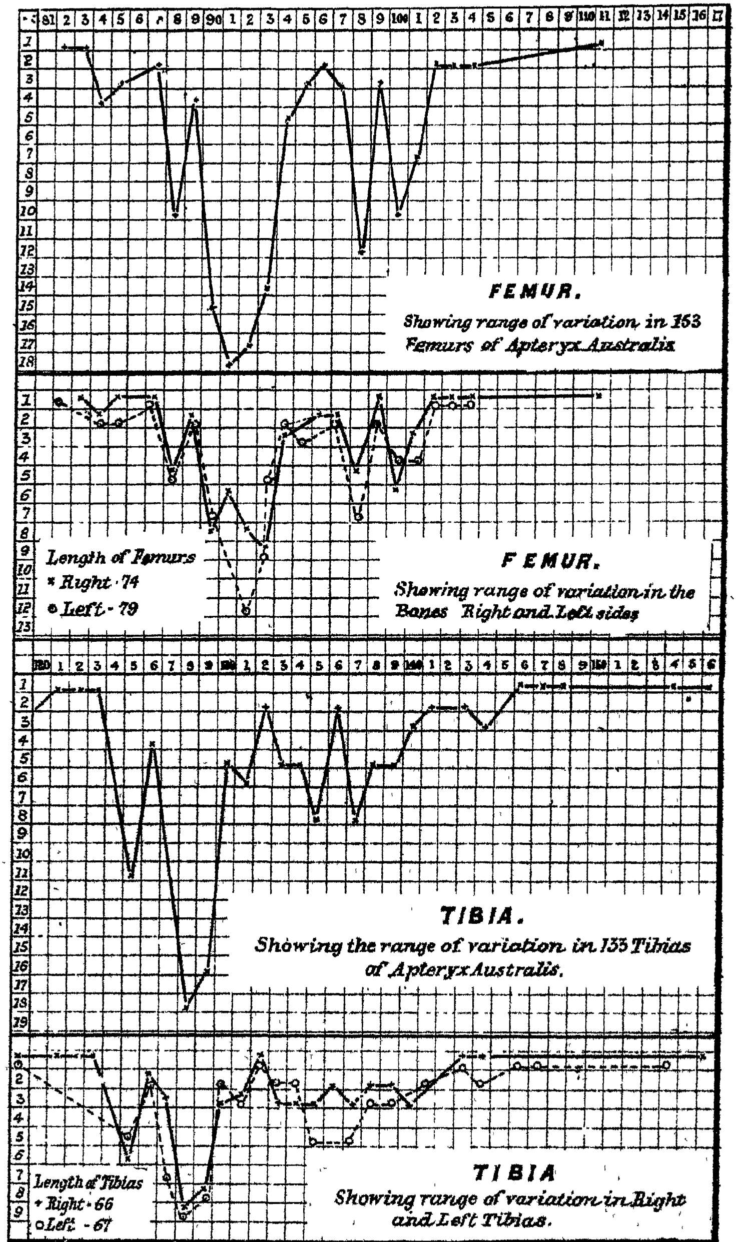

APTERYX AUSTRALIS.
Showing range of variation in 11
Metatarsus bones.
Measurements of
Metatarsus. —
× Right 59
Left 58
APTERYX AUSTRALIS.
Showing range of variation in
Right & Left Metatarsus.
ANAS FINSCHII
Metatarsi of
Anas Finschii
88 ○ Right
108 × Left
196
ANAS FINSCHII
Femora of
Anas Finschii
127 ○ Right
132 × Left
259

Harpagornis moorei
(lower view)

Harpagornis moorei
(side view)


FEMUR.
Showing range of variation in 153 Femurs of Apteryx Australis
Length of Femurs
* Right · 74
o Left - 79
FEMUR.
Showing range of variation in the Bones Right and Left sides
TIBIA.
Showing the range of variation in 133 Tibias of Apteryx Australis.
Length of Tibias
+ Right - 66
o Left - 67
TIBIA
Showing range of variation in Right and Left Tibias.

Orthagoriscus mola

To illustrate Paper by G. V. Hudson F.E.S.

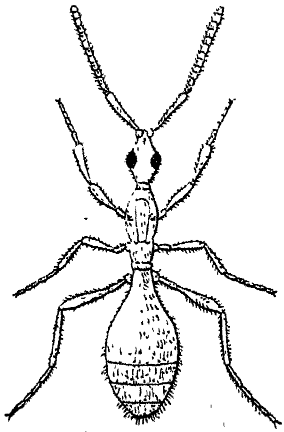


Fig. 1.

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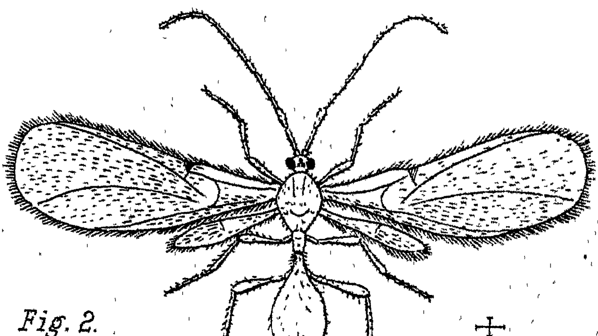
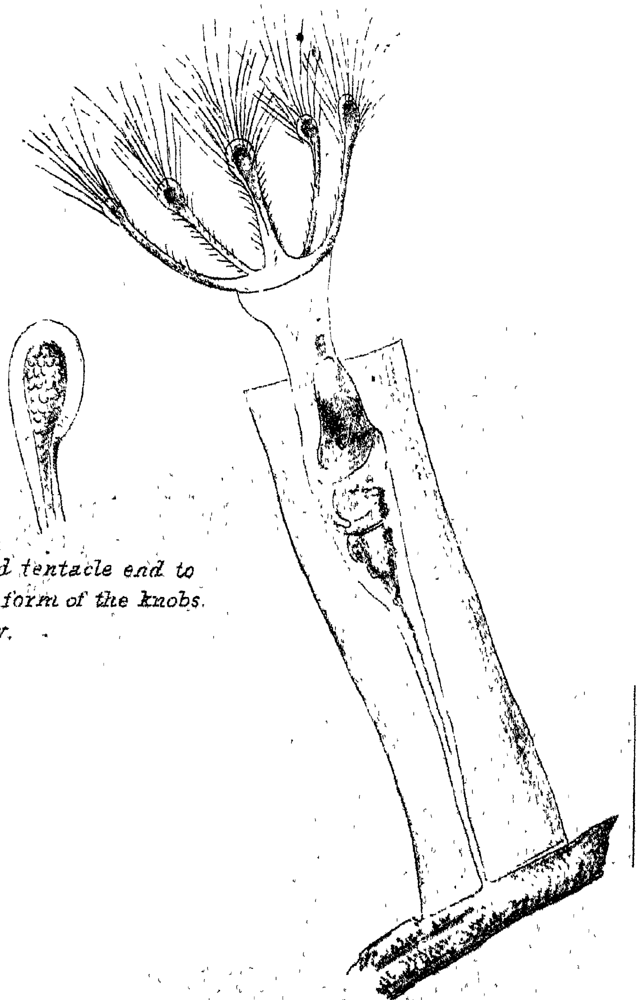


Fig. 2.

♂

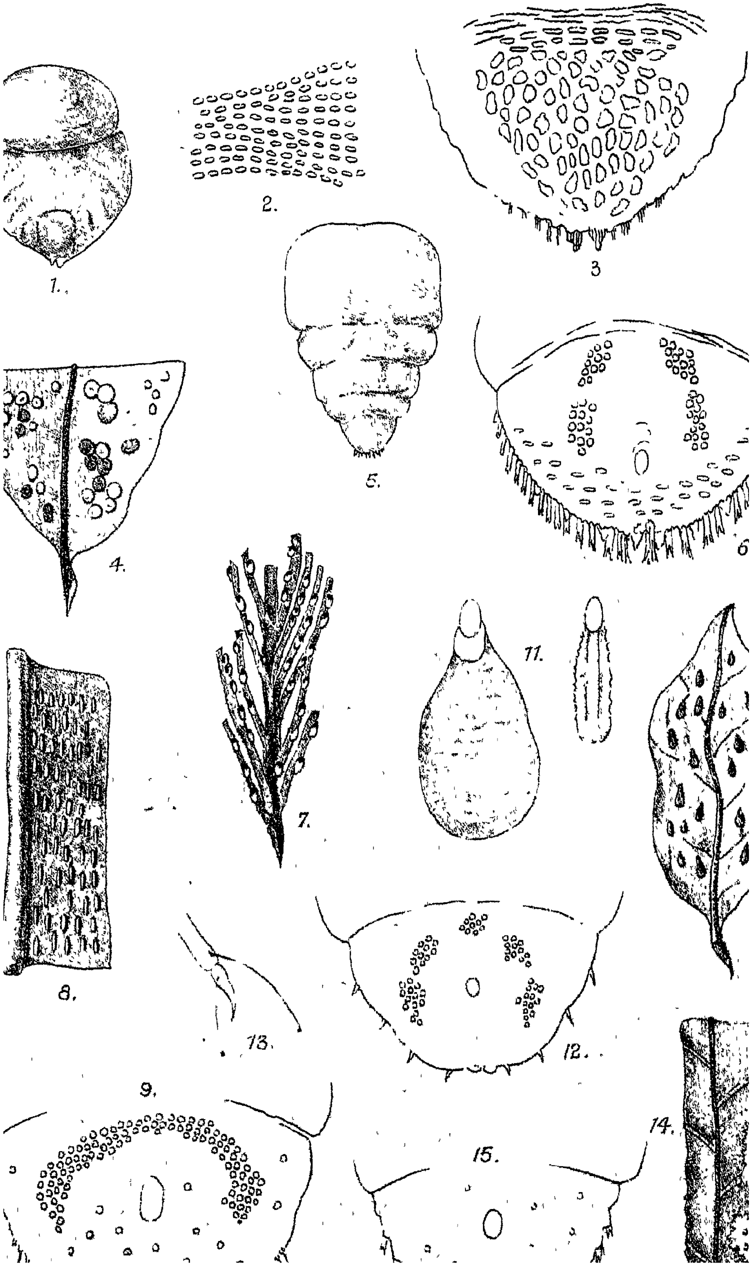
BUG PARASITE ON THE GLOWWORM.

To illustrate Paper by Archd.^{n} Stock.



Enlarged tentacle end to shew the form of the knobs. side view.

Floscularia coronetta.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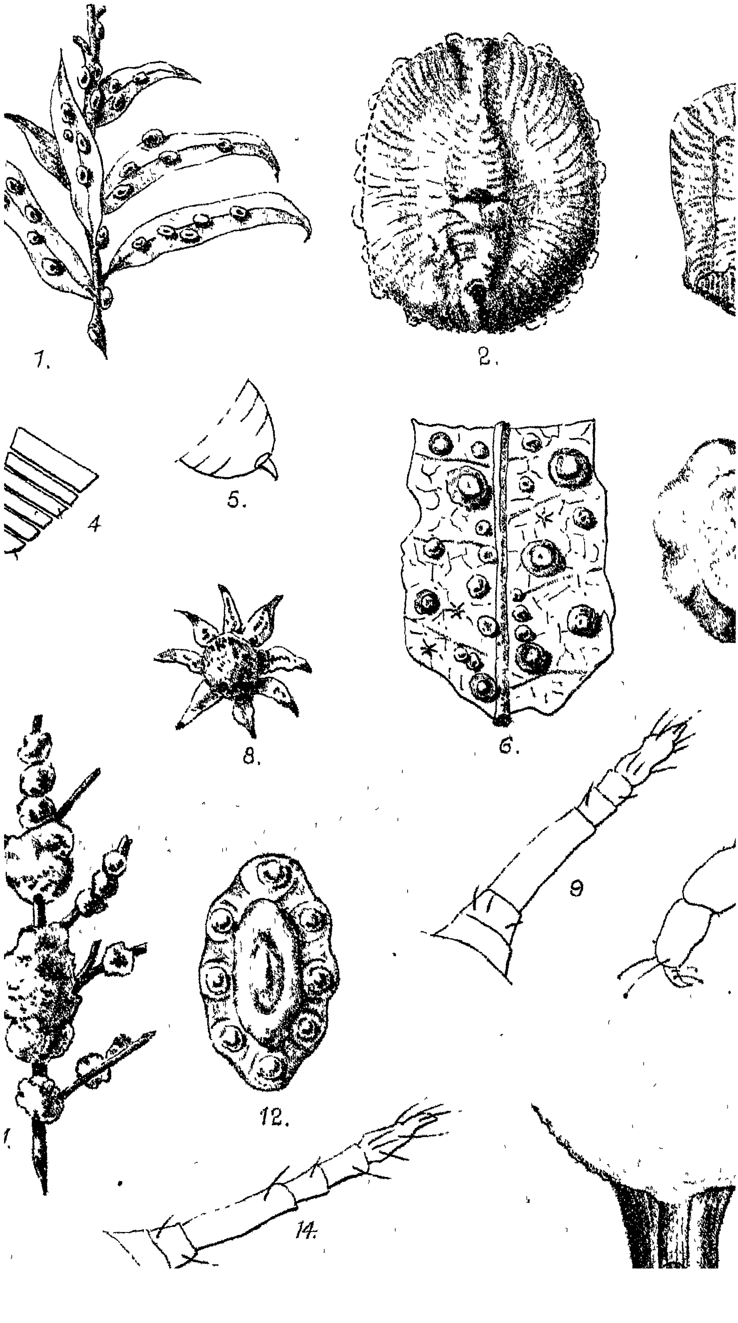
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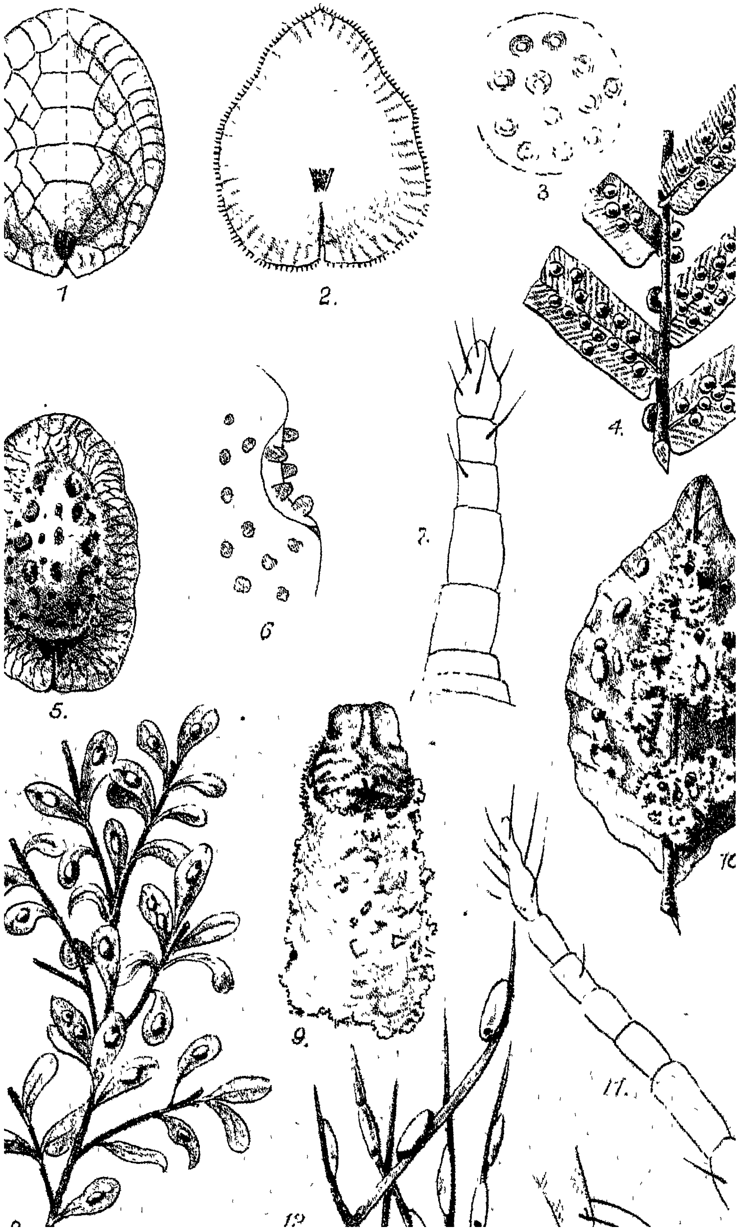
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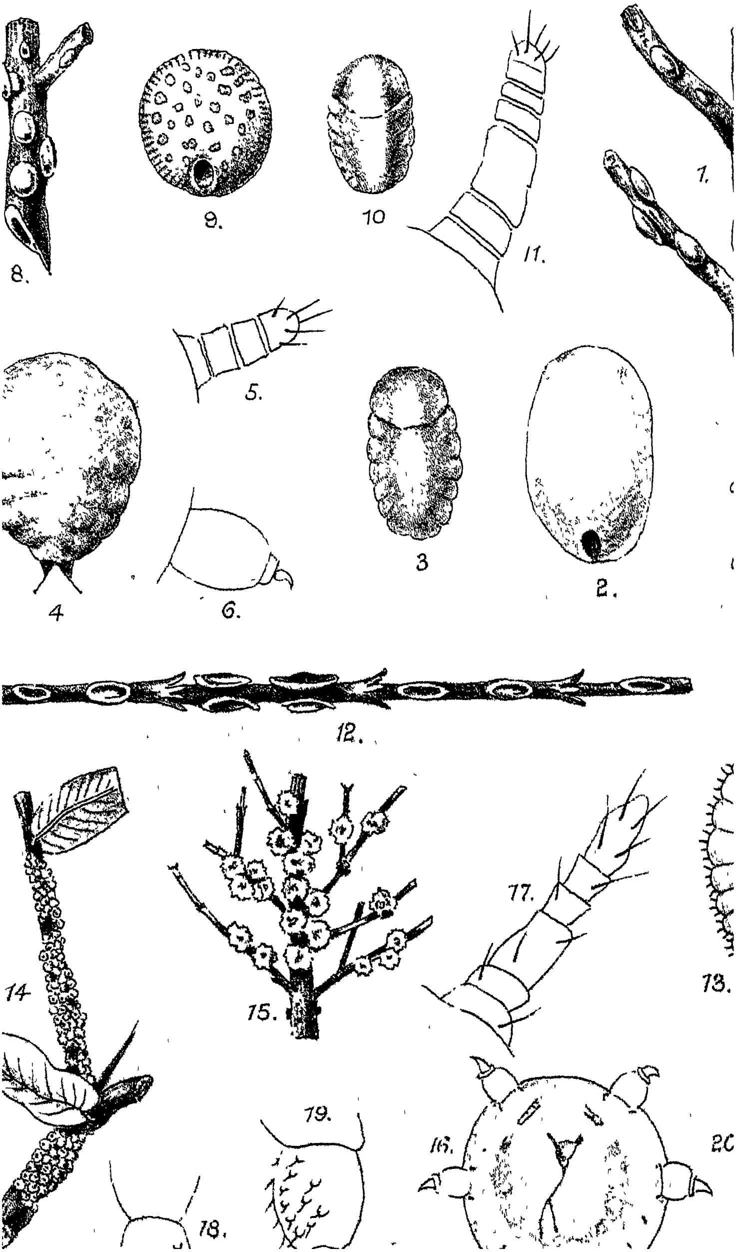
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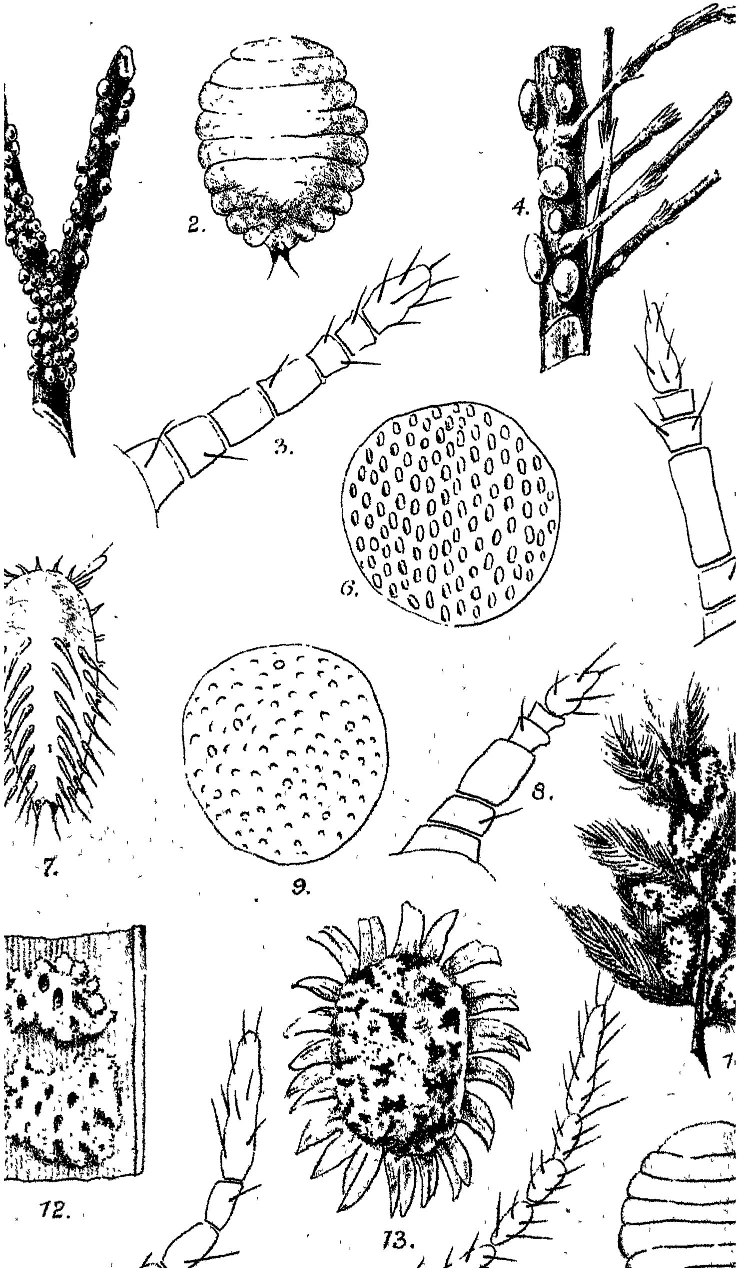
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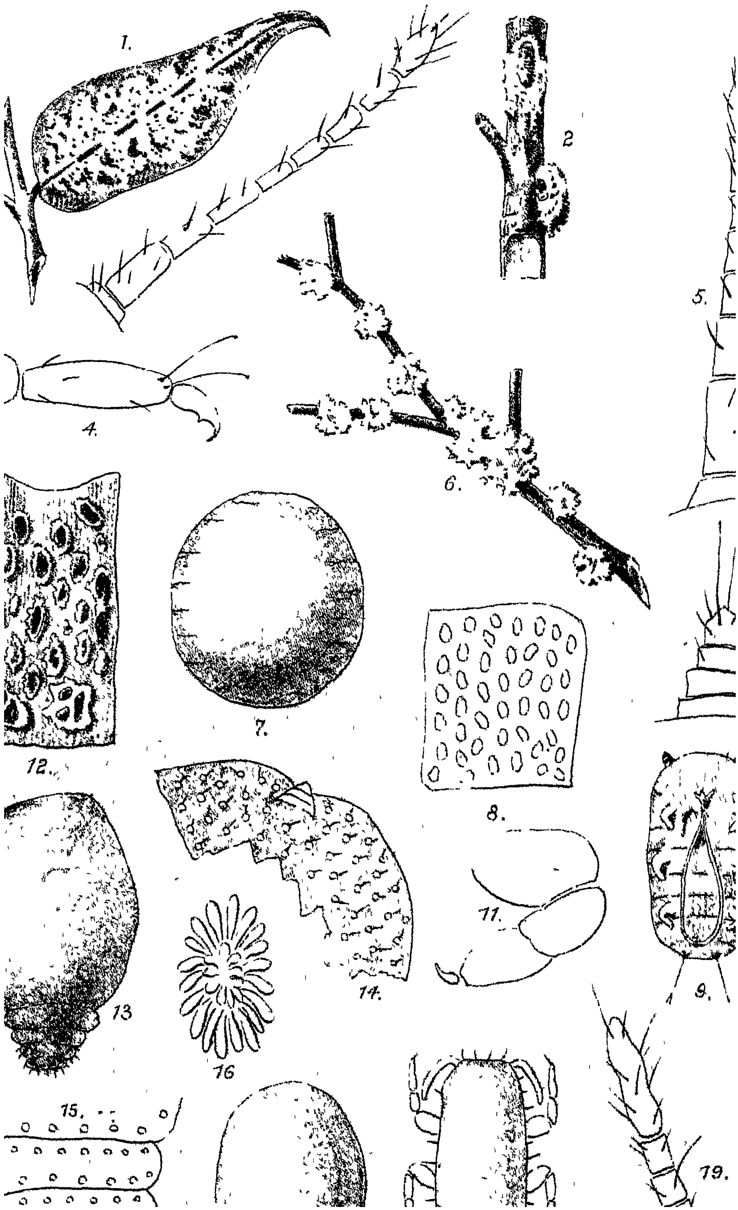
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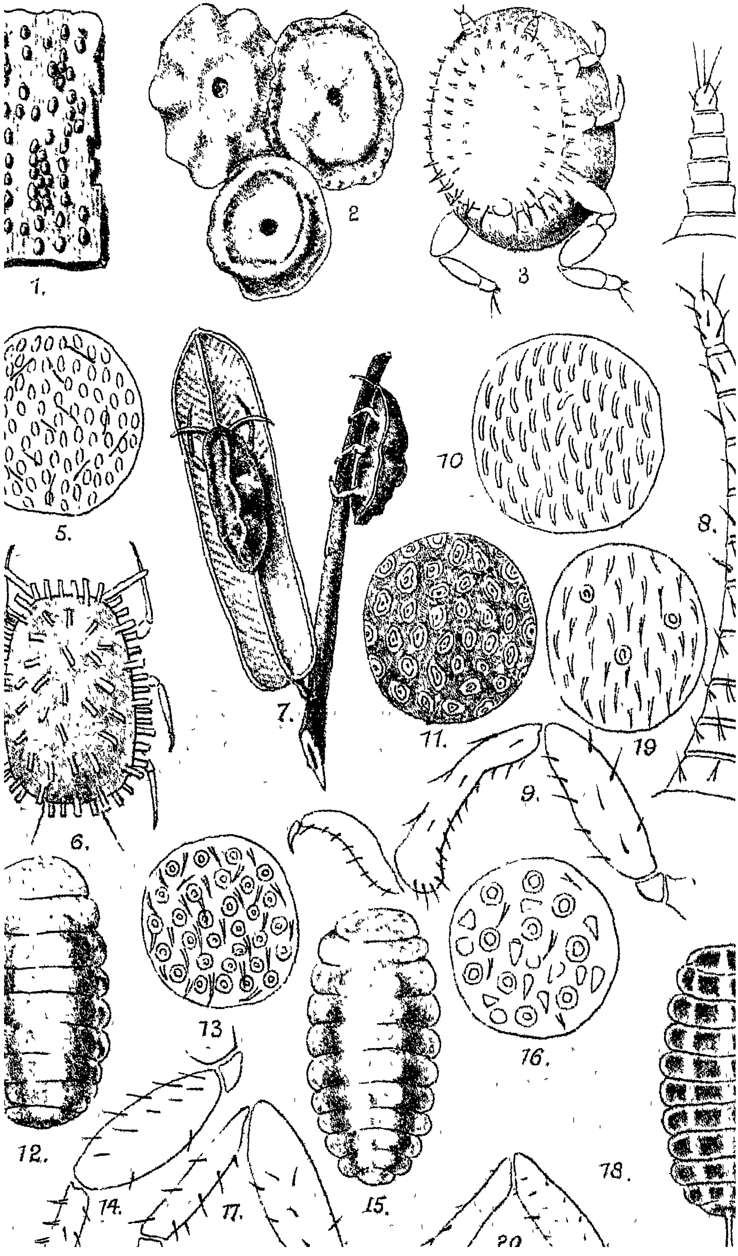
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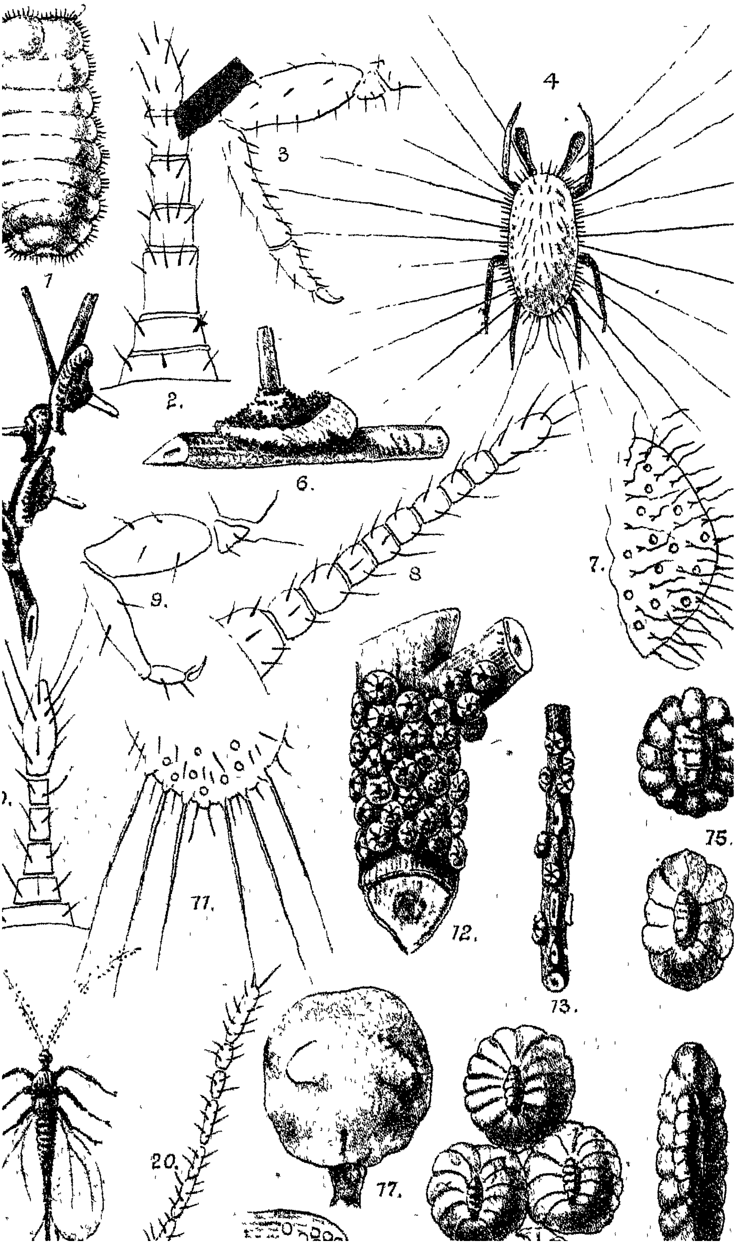
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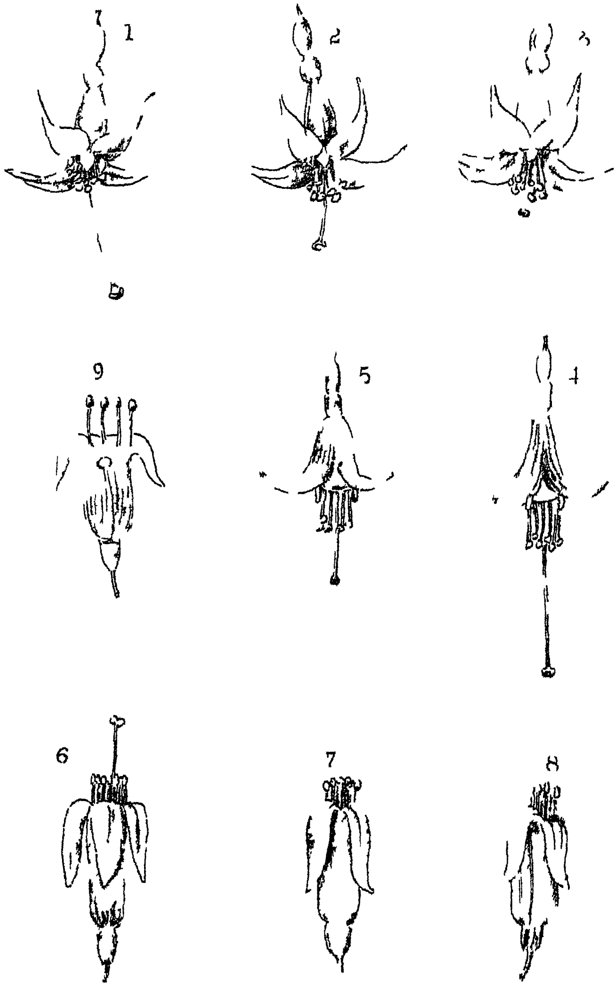
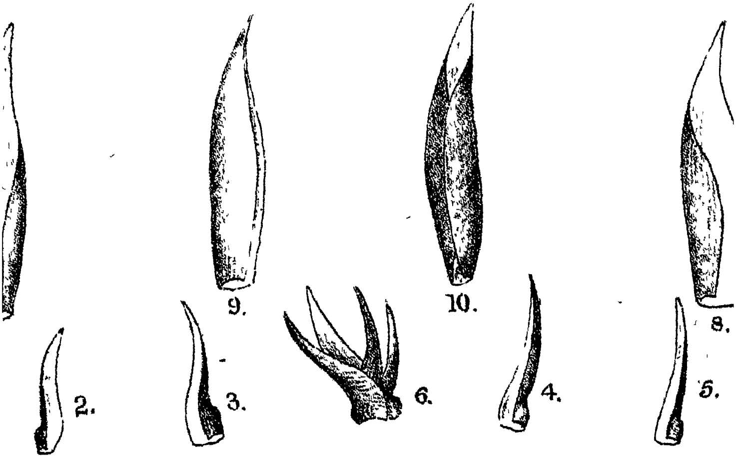


Flowers of N Z Fuchsias

To illustrate paper by D. Petrie.



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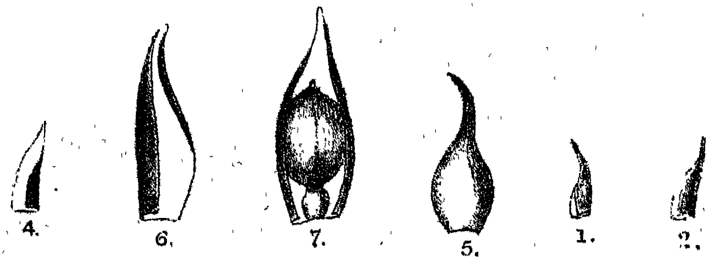
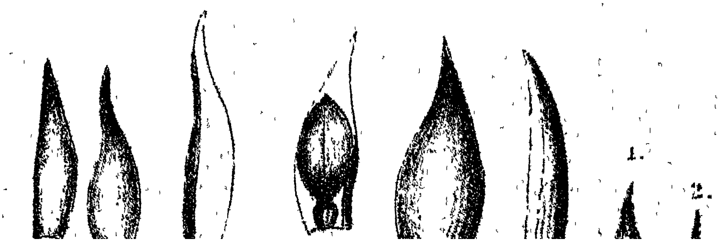
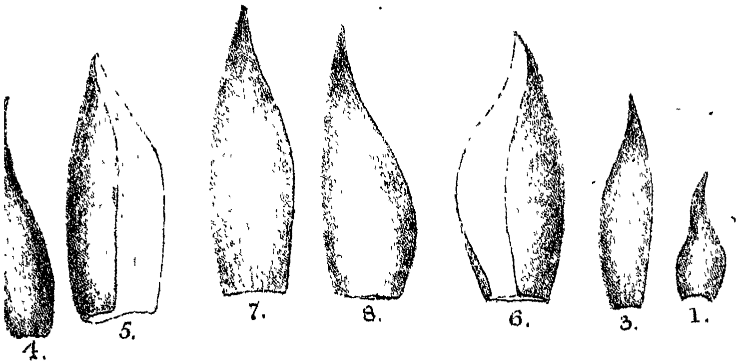


Andreæa dioica sp. nov.





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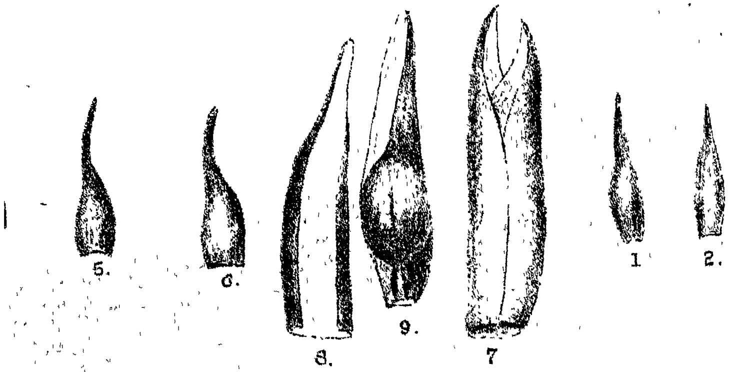

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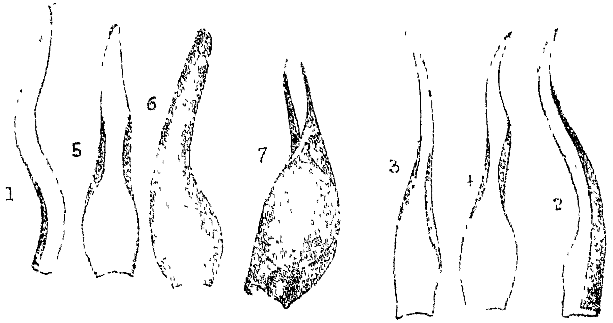

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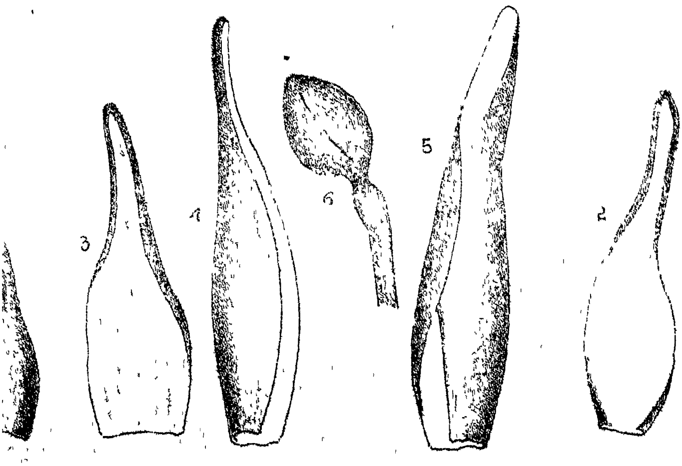

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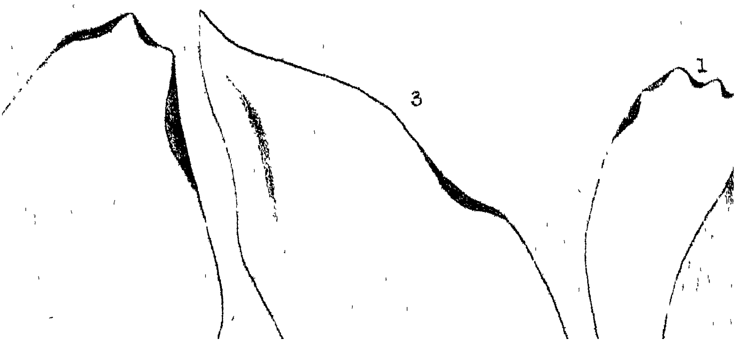

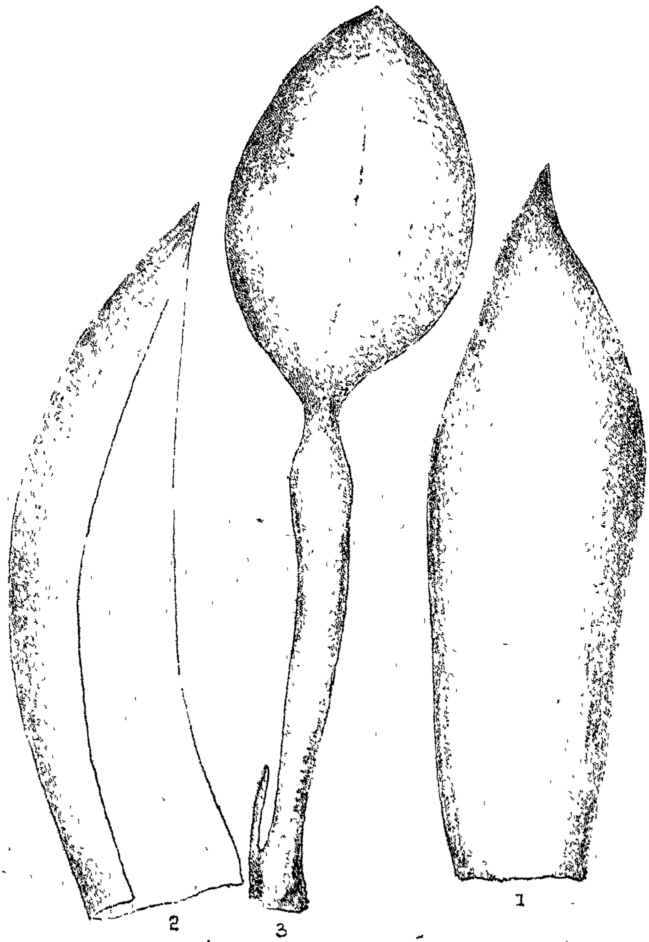

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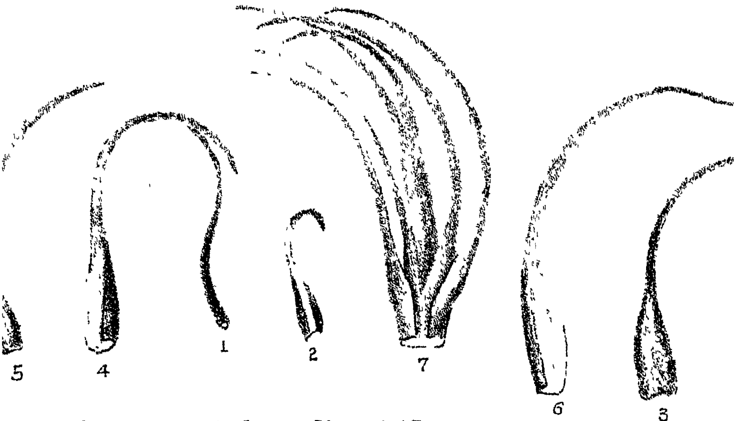

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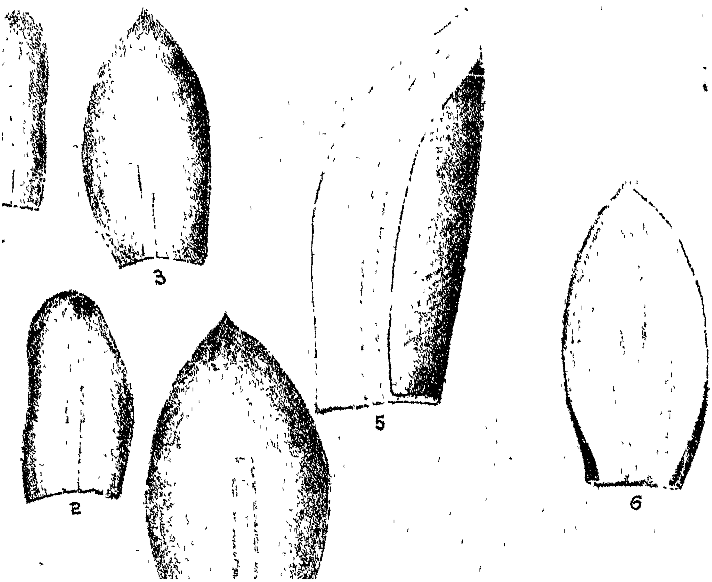

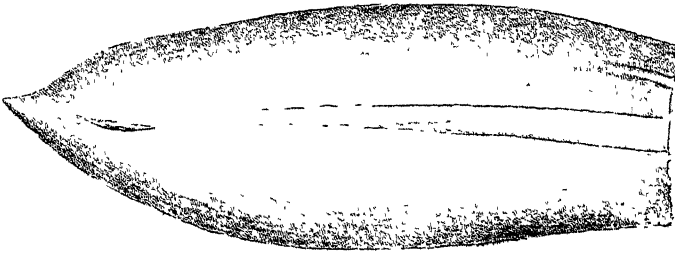

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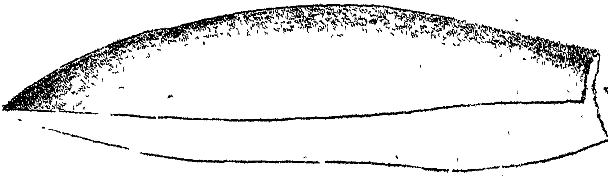

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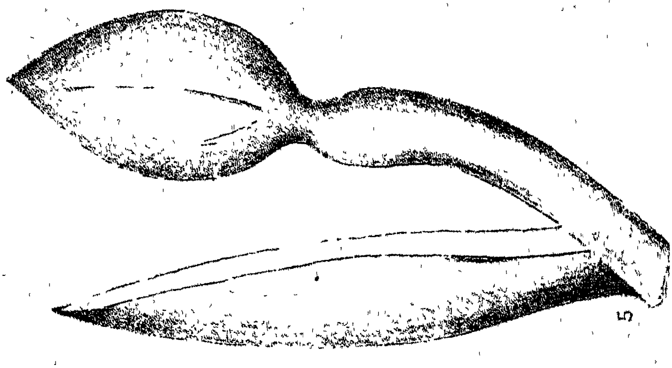

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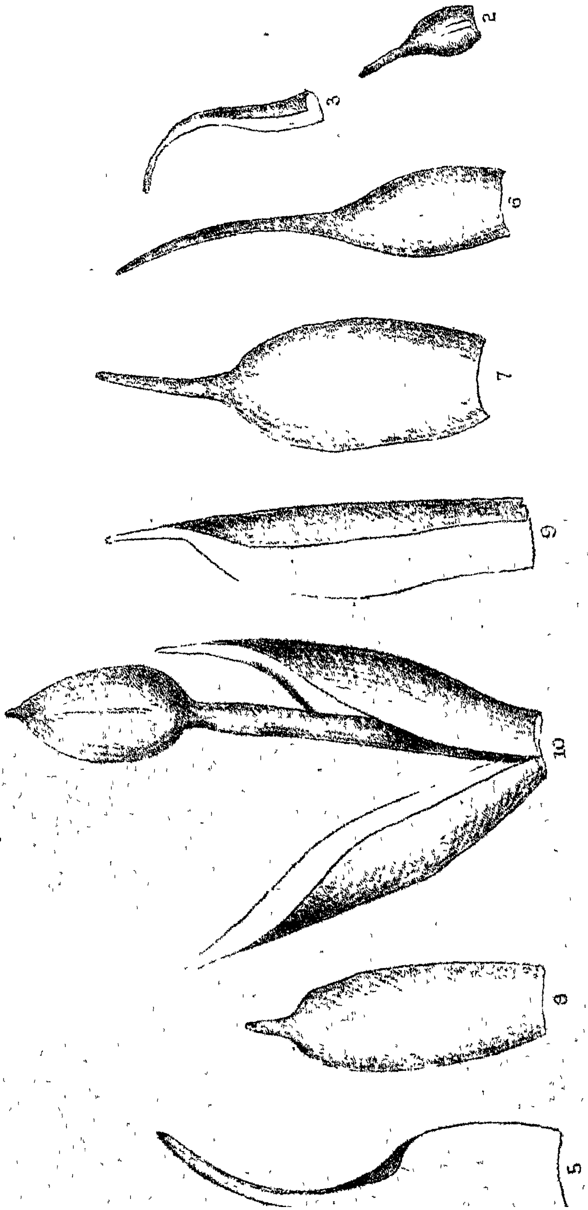
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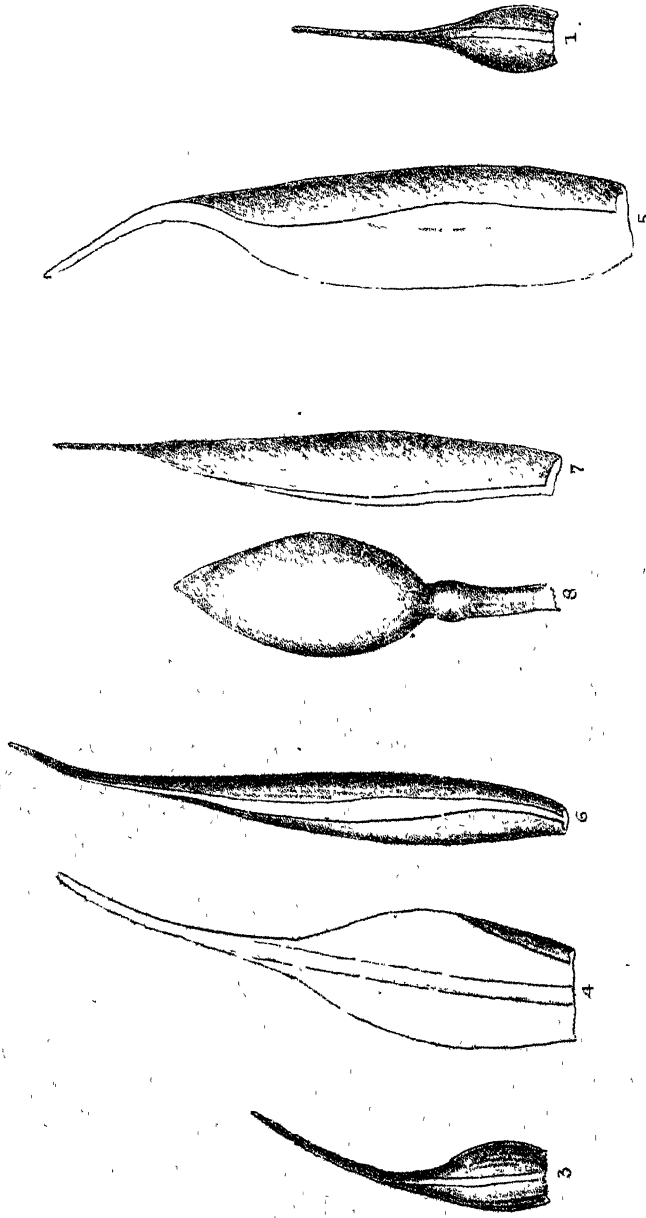
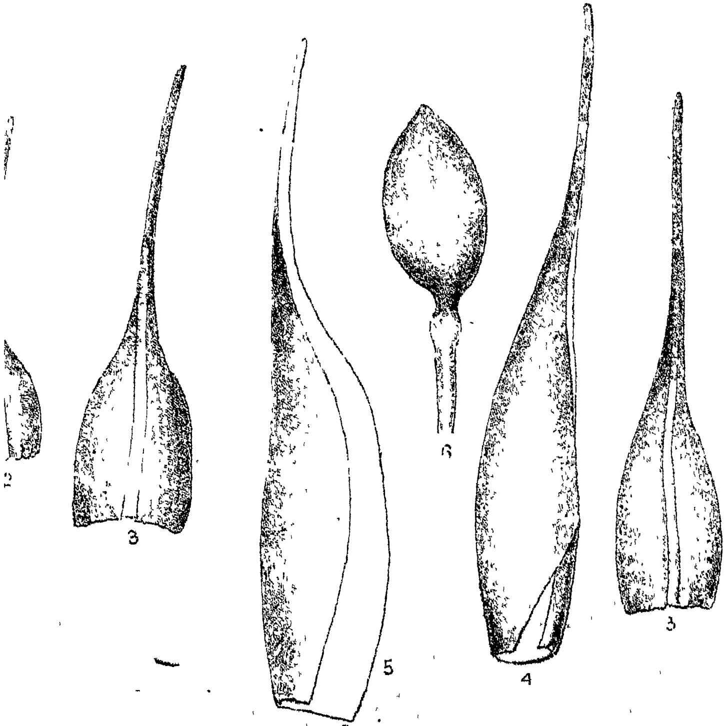
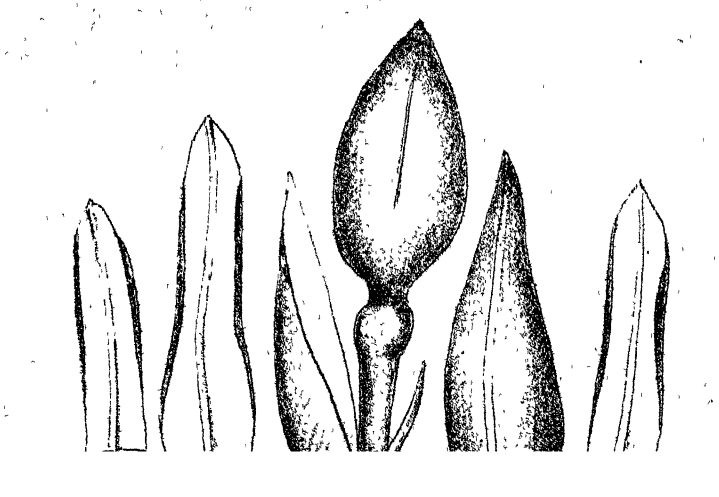


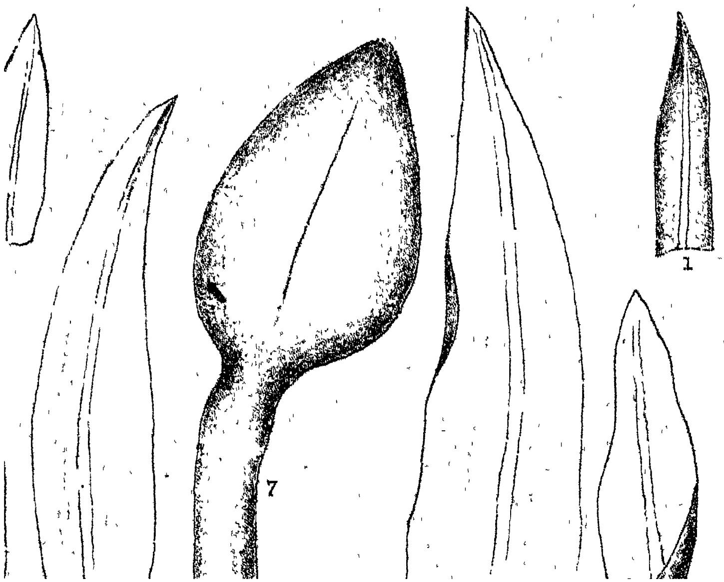
Andreaea Jonesii sp nov



Andreæa Jonesii sp nov var 3.



Andreæa lanceolata sp. nov.



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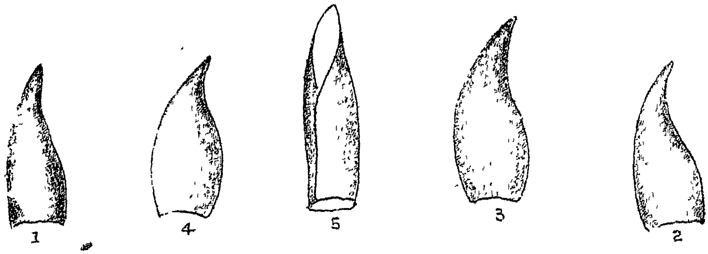
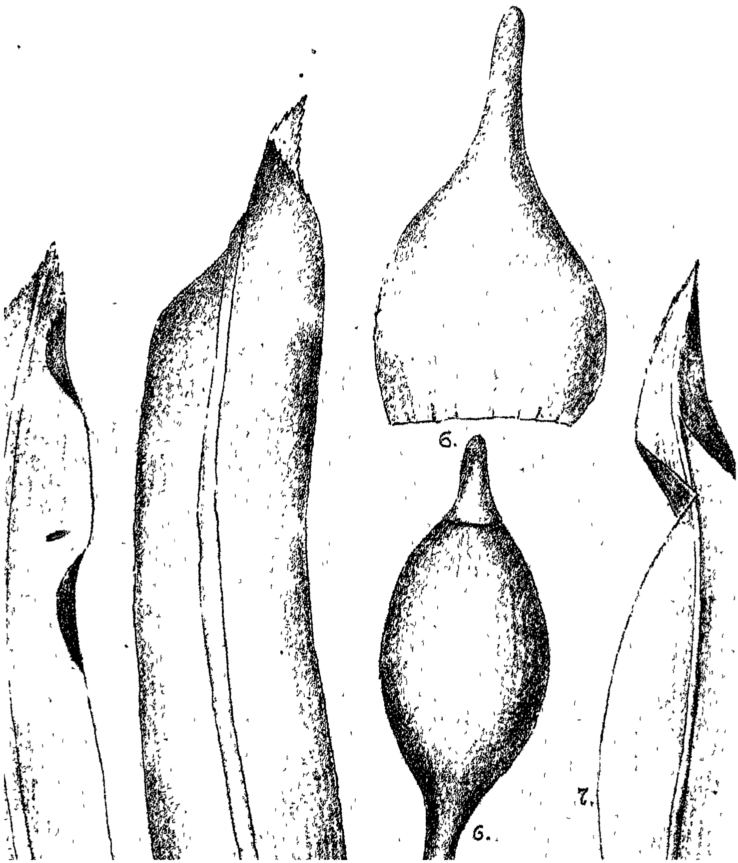
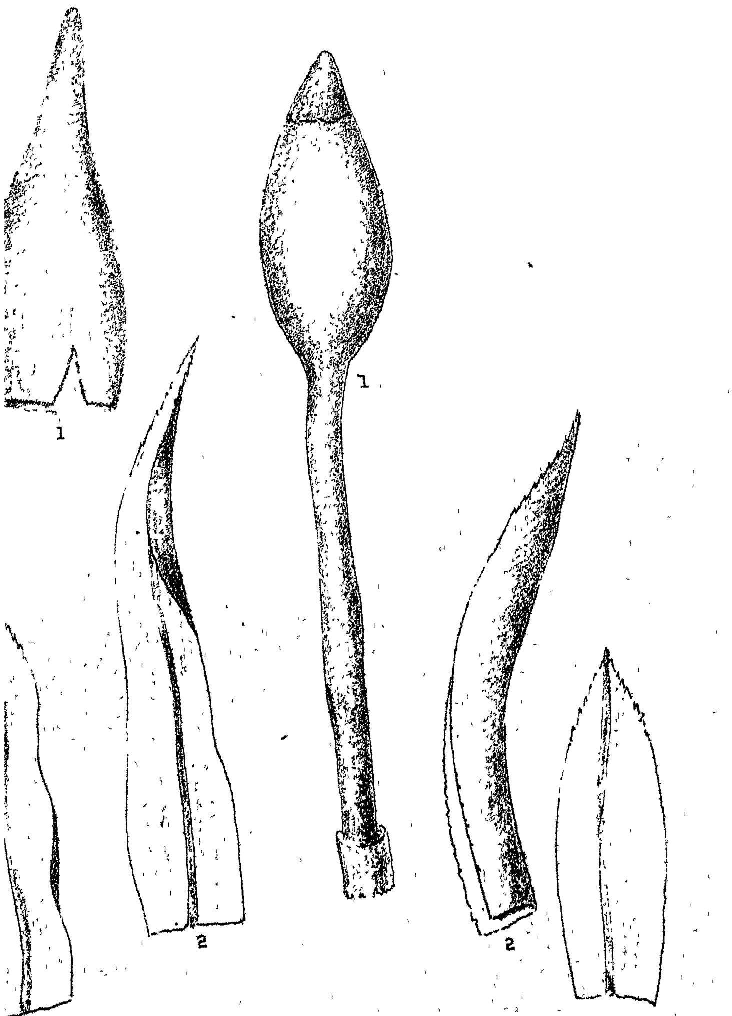
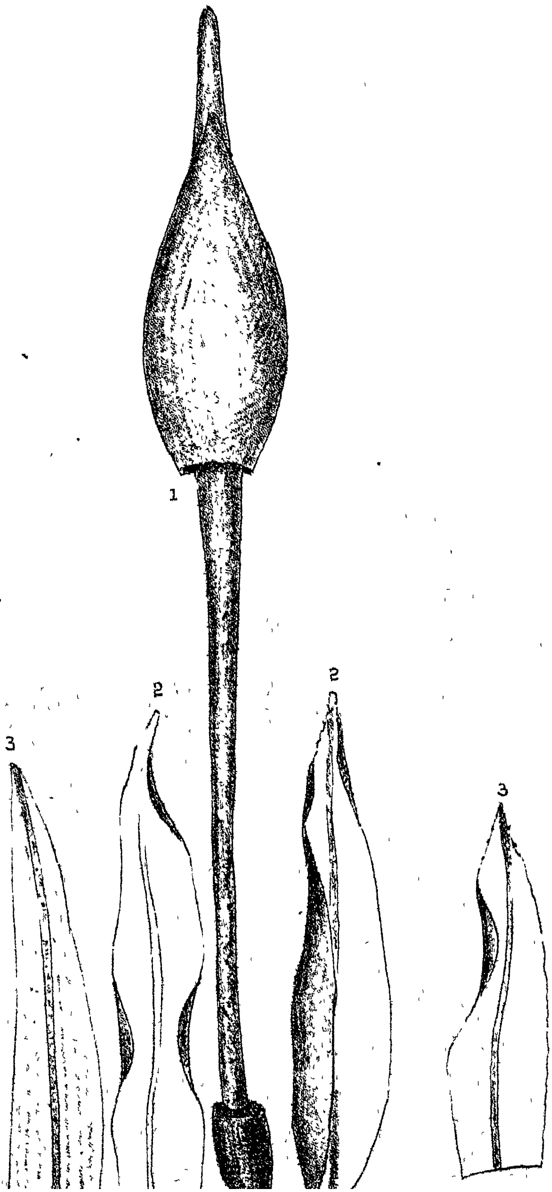


Andreæa petrophila Ehrhart





Hennedia intermedia sp. nov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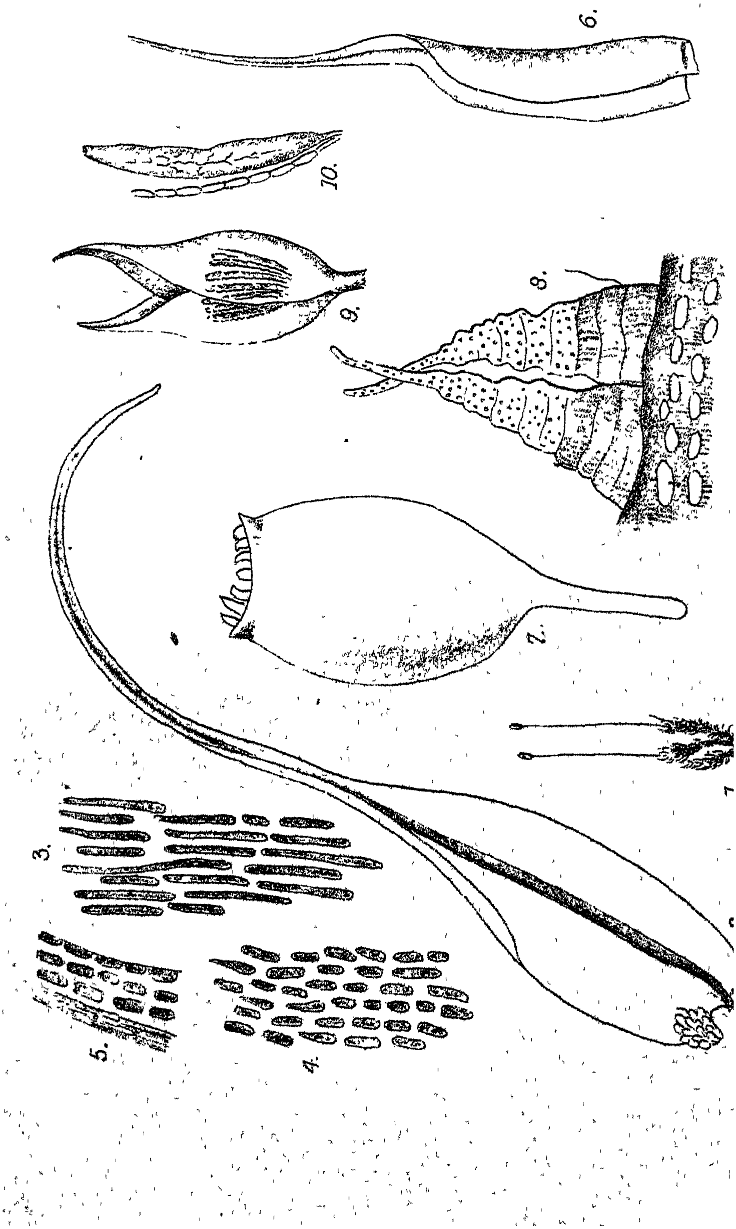
2
2
3
3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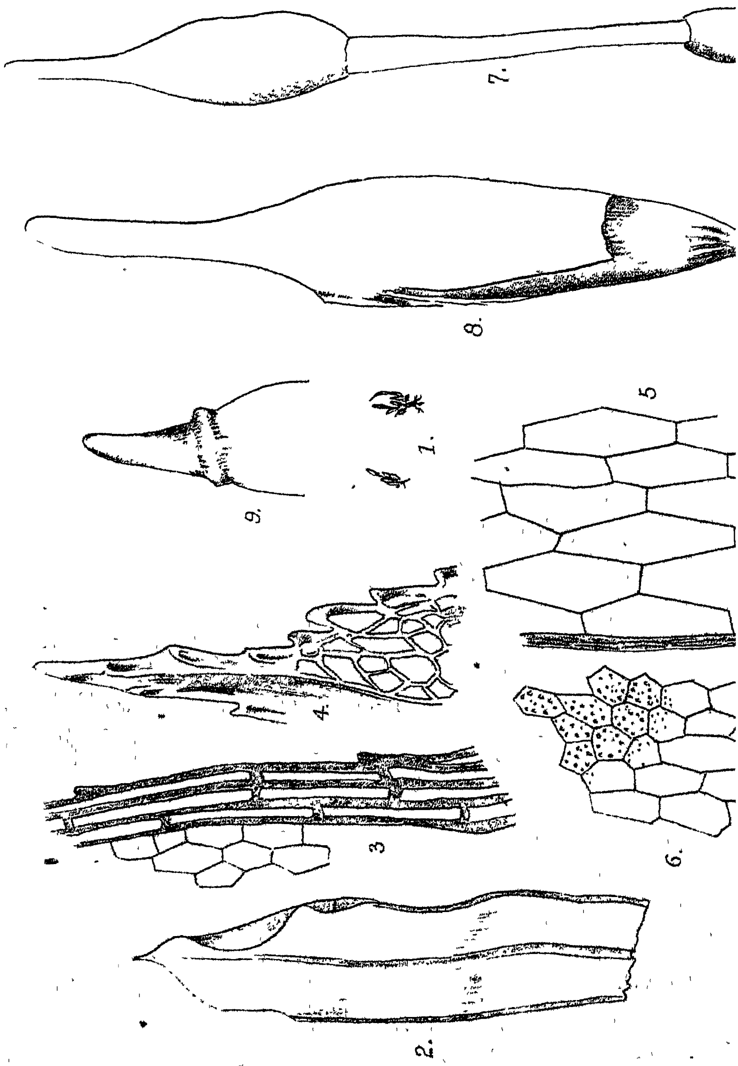
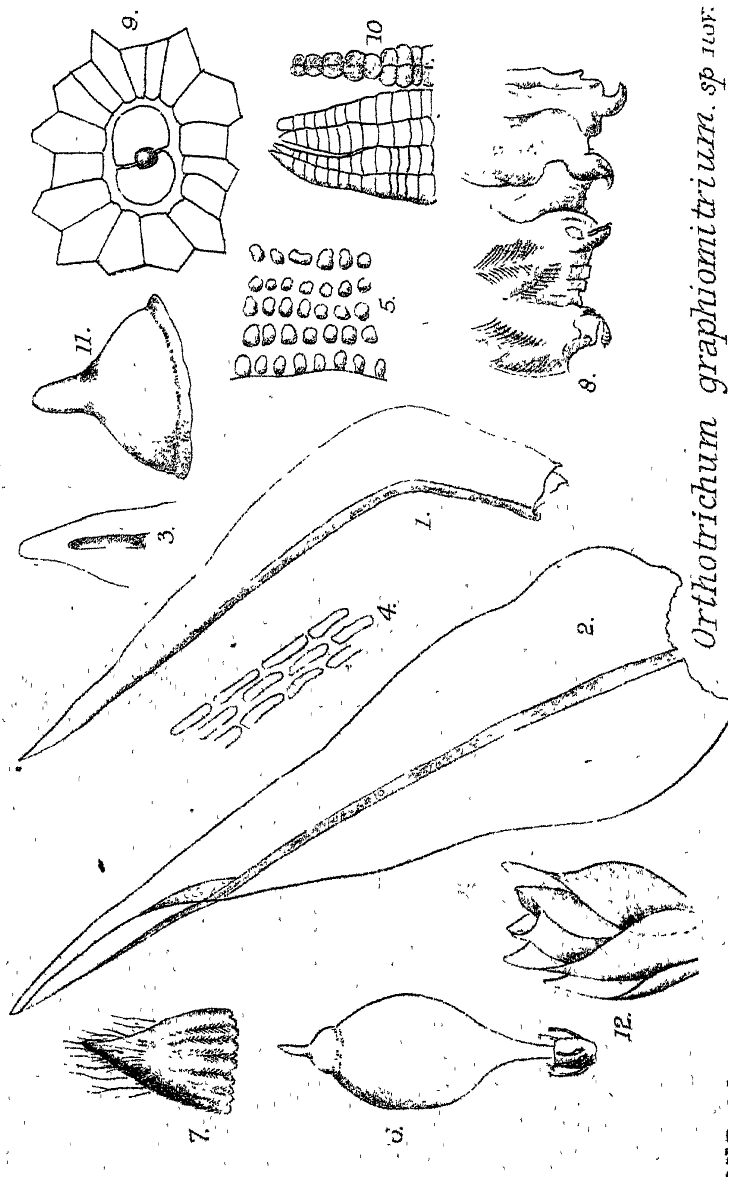
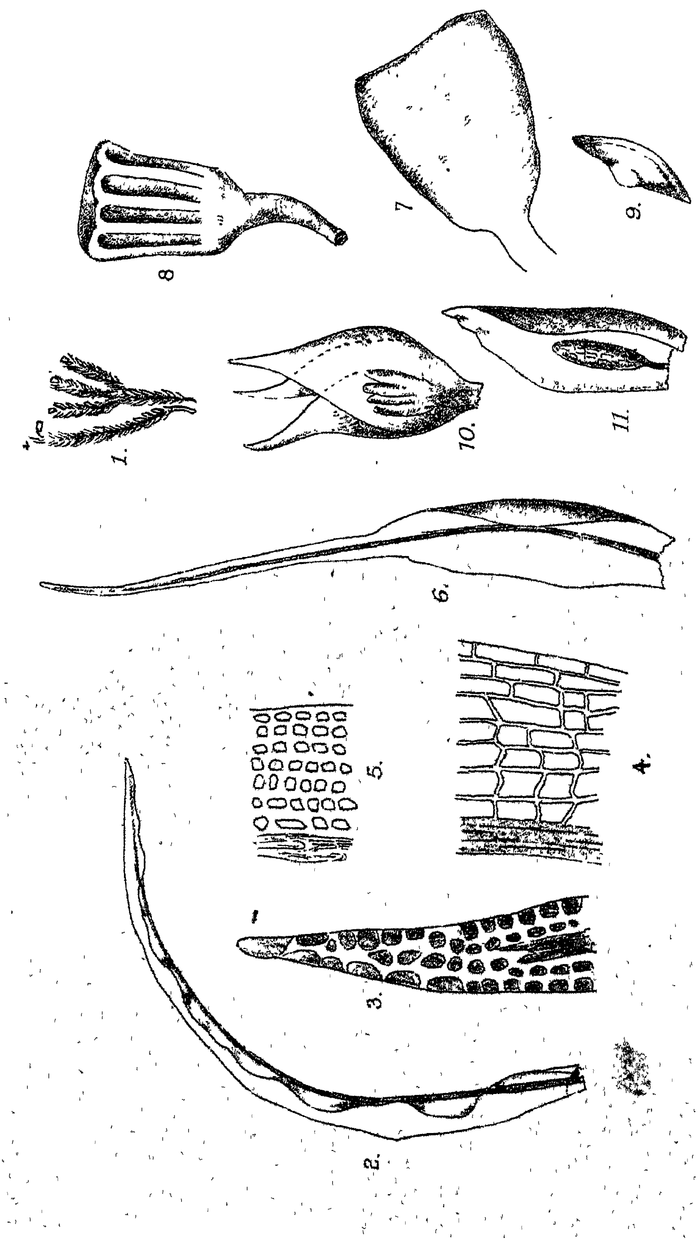
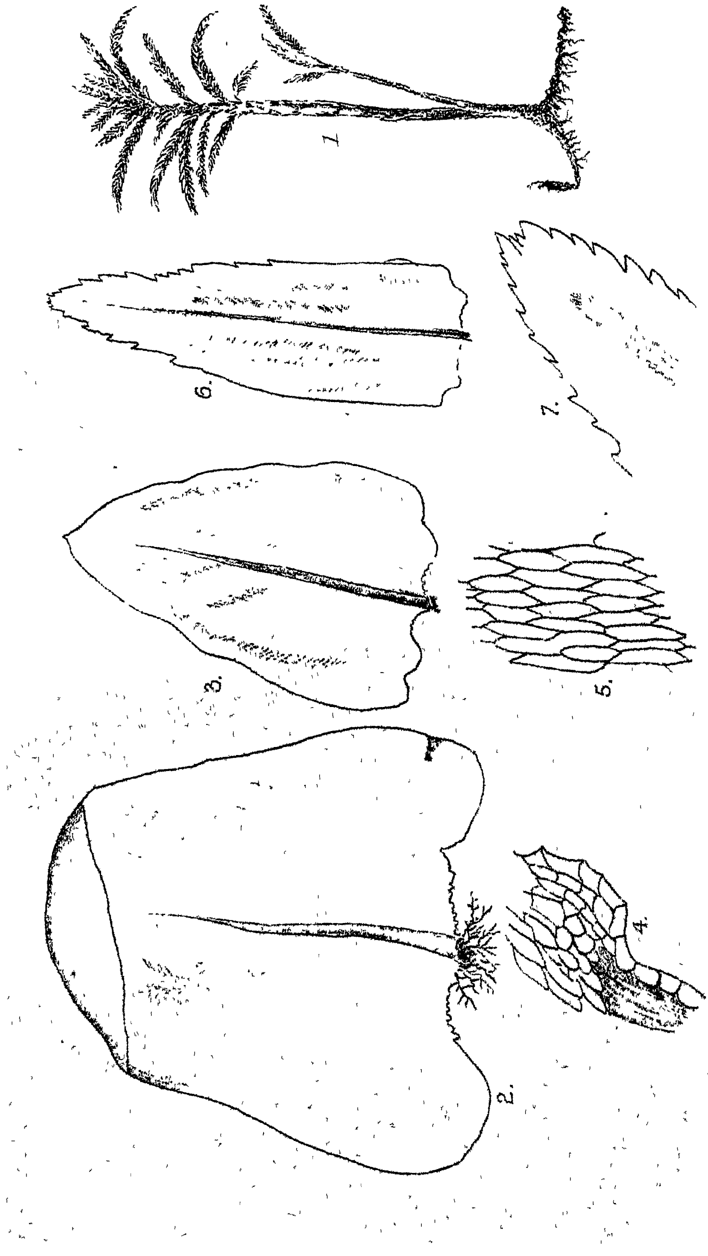




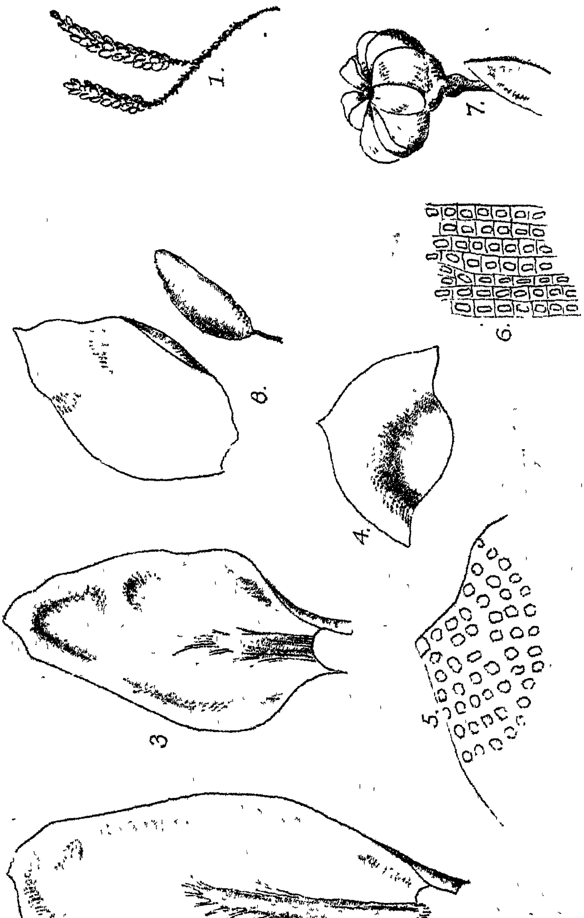
Orthotrichum graphiomitrium. sp nov.



Zygodon integrifolius, sp. nov.

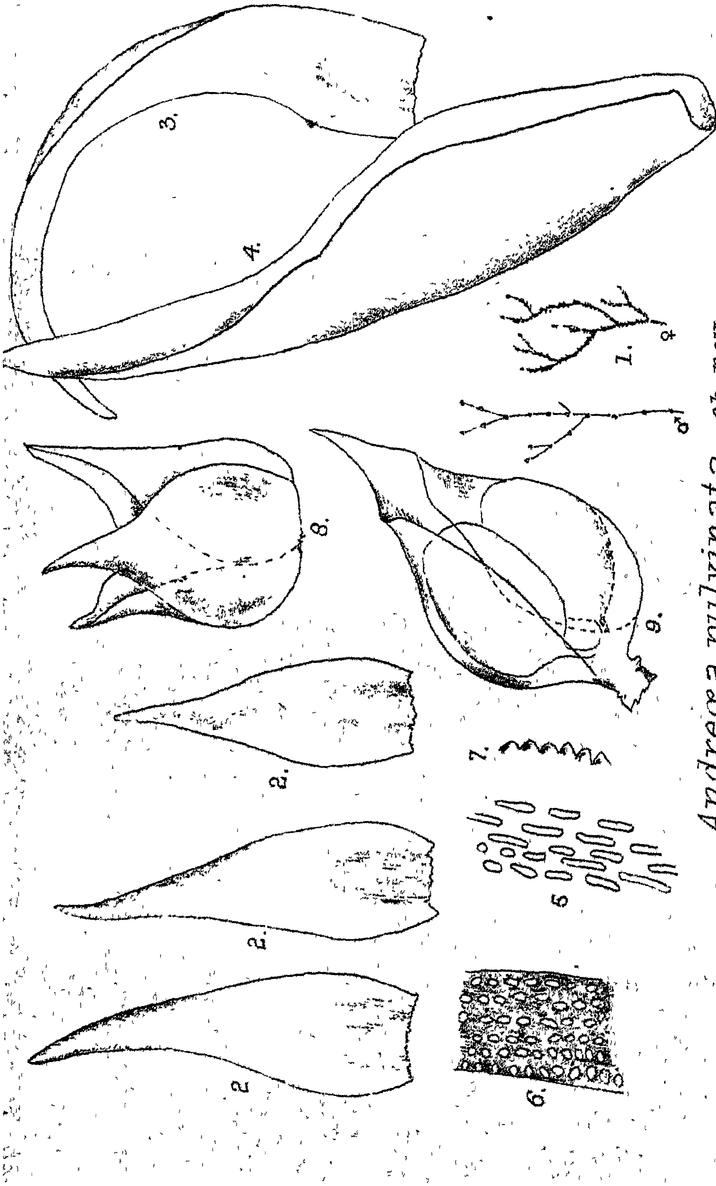


Climacium Novæ-Seelandiæ sp. nov.

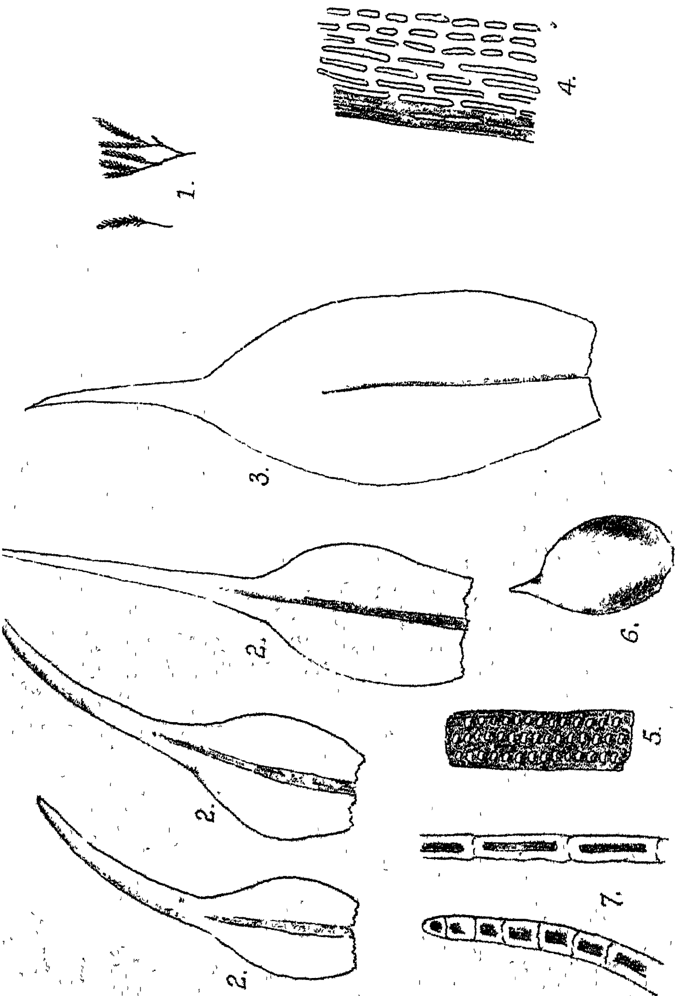


Andreæa cochlearifolia. sp nov.

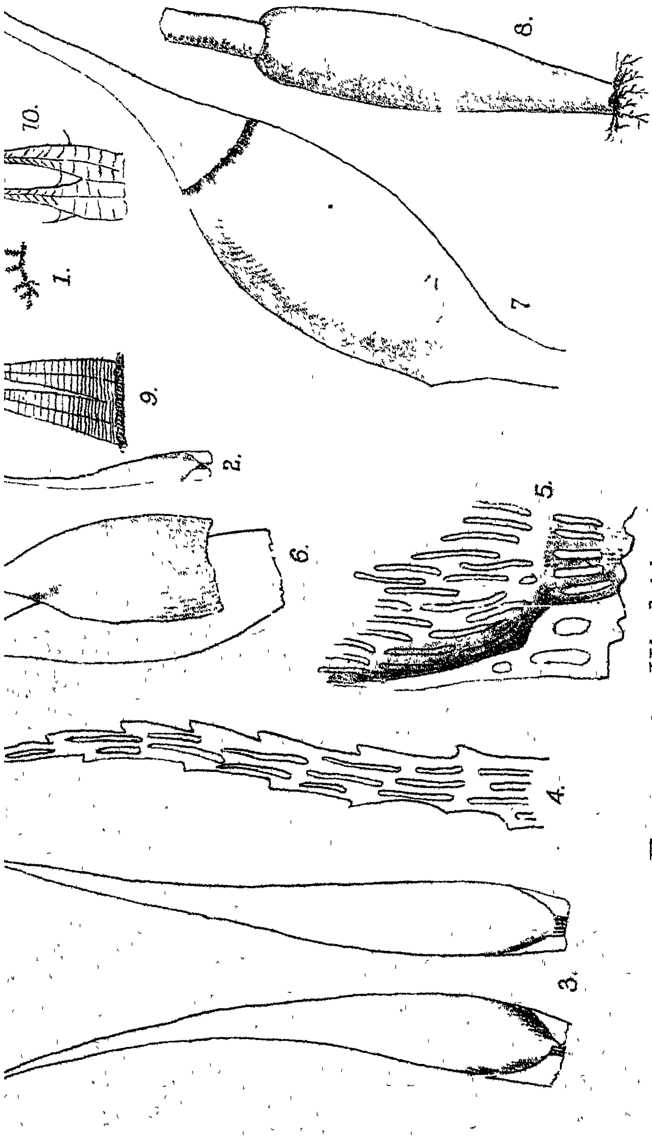
W. N B del.



Andreæa pulvinata. sp. nov.

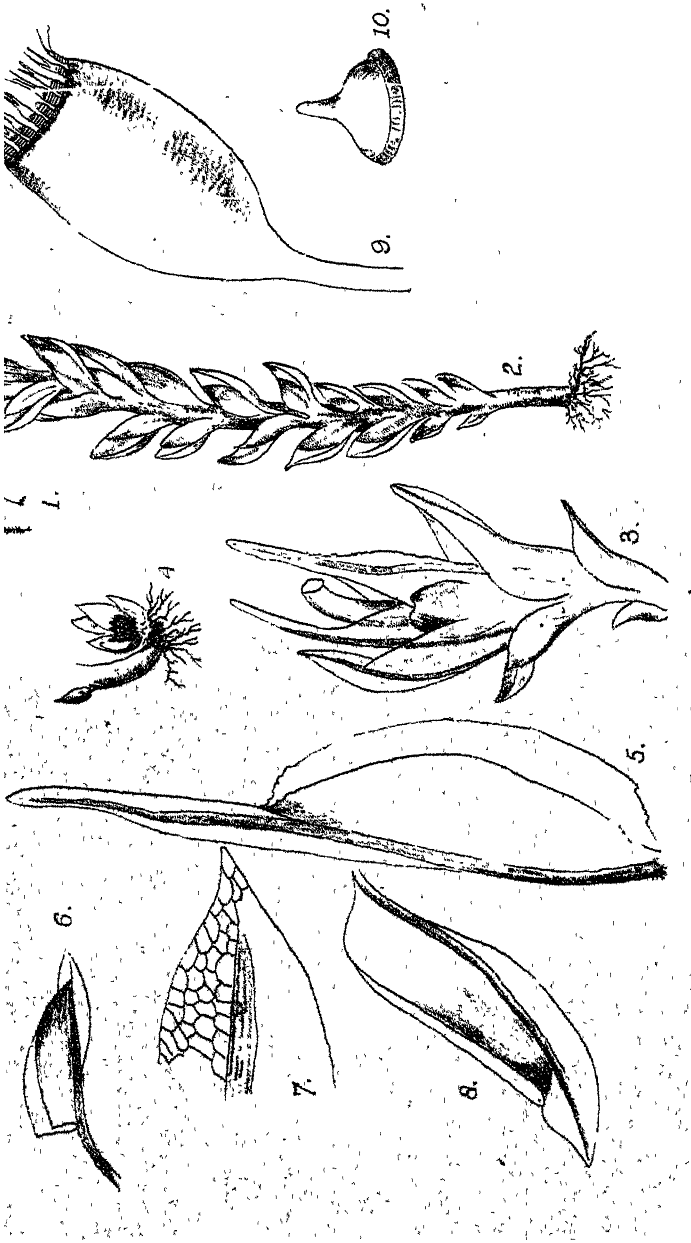


Andreæa arctoæoides. sp. nov.

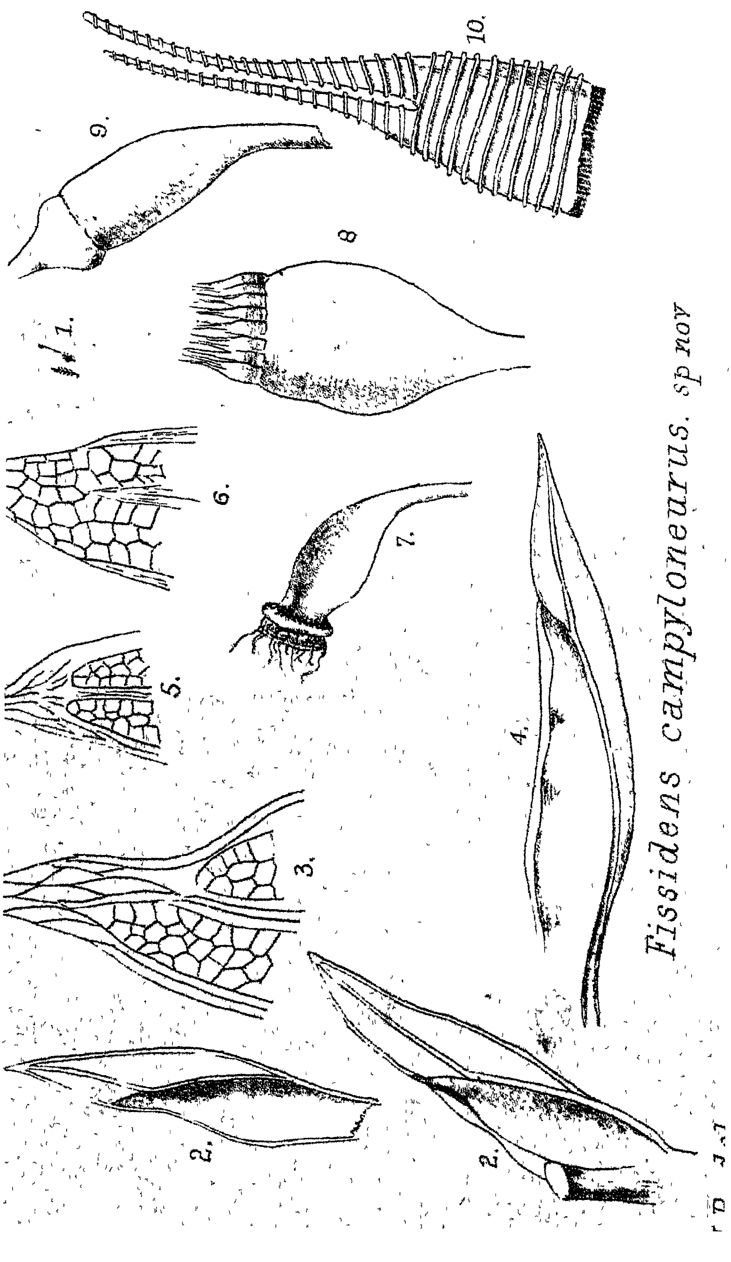


Hypnum Kirkii sp. nov.

del.

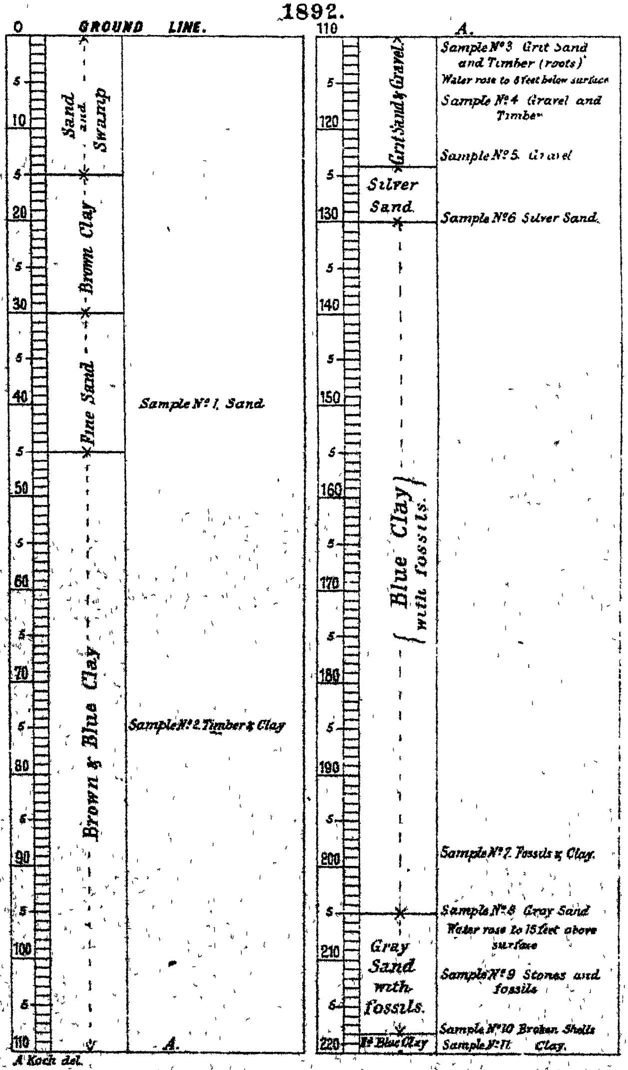


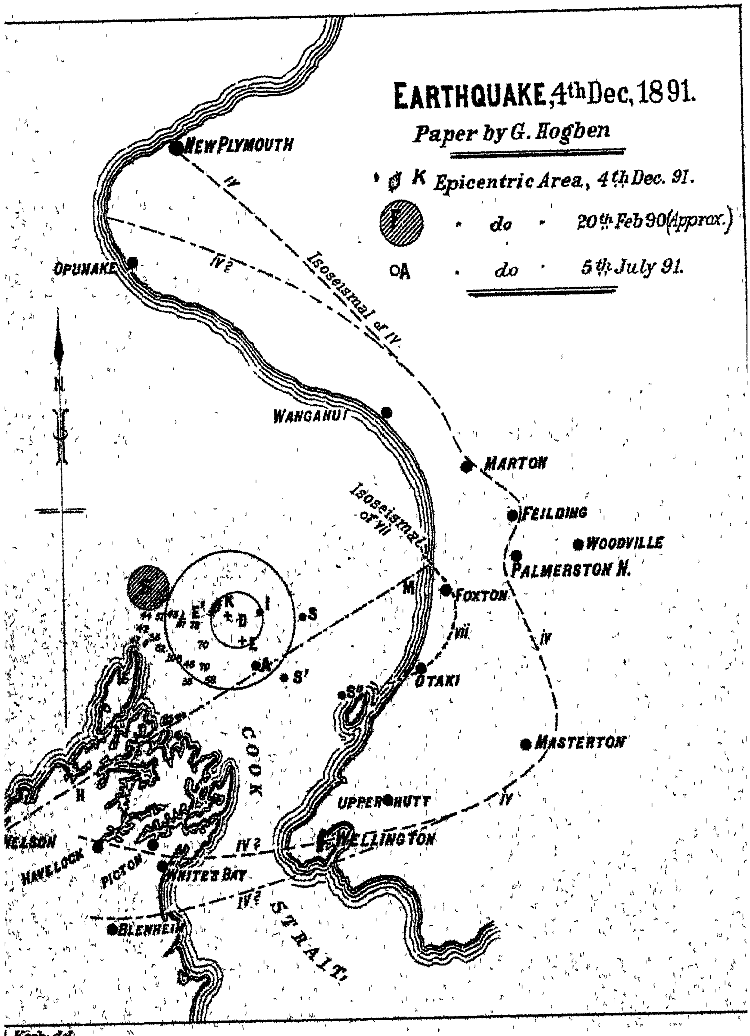
Fissidens ramiger sp nov.



Fissidens campyloneurus. sp nov

SECTION OF FIRST ARTESIAN WELL in Campbell Street WANGANUI 1892.




EARTHQUAKE, 4th Dec, 1891.
Paper by G. Hogben
K Epicentric Area, 4th Dec. 91.
do 20th Feb 90 (Approx.)
A do 5th July 91.
NEW PLYMOUTH
OPUNAKE
WANGANUI
MARTON
FEILDING
WOODVILLE
PALMERSTON N.
FOXTON
OTAKI
MASTERTON
UPPER HUTT
WELLINGTON
NELSON
HAVELOCK
PICTON
WHITE'S BAY
BLENHEIM
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STRAIT
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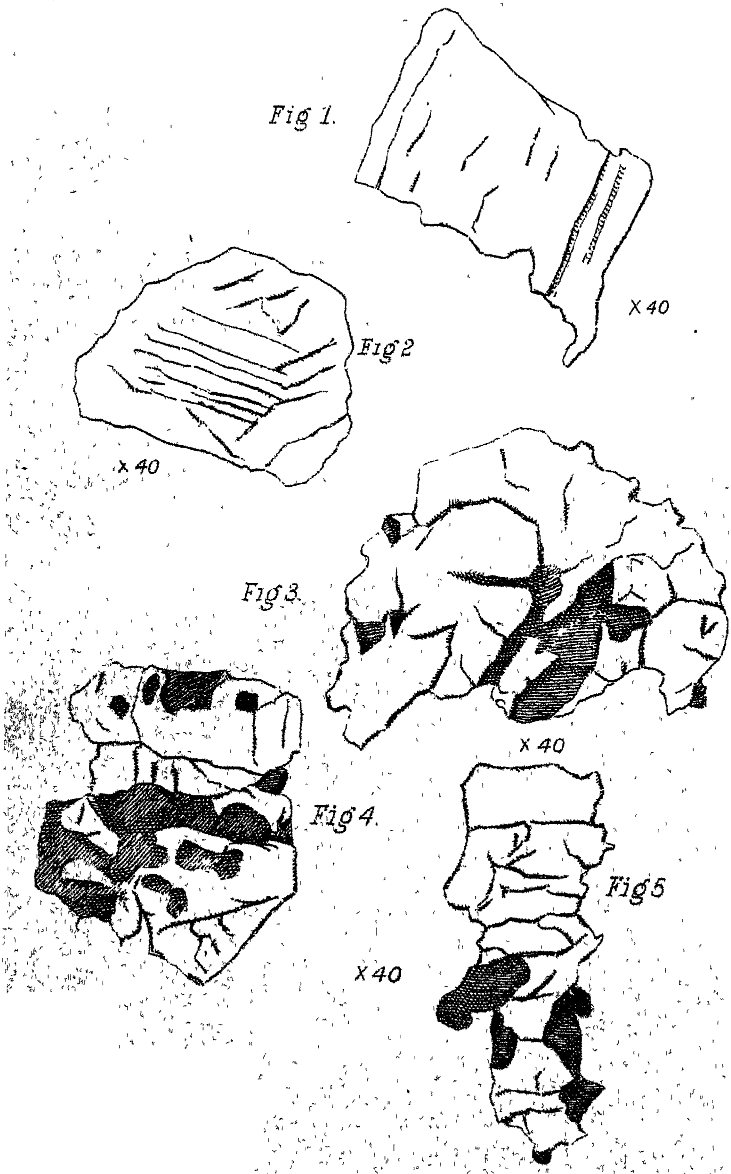
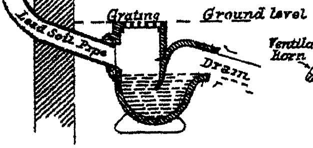


Olivine Andesite.

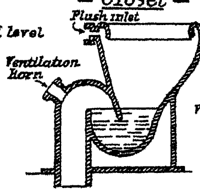
— Fig 1 —

Intercepting Trap



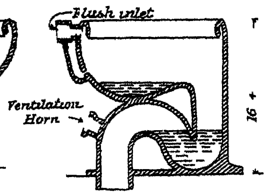
— Fig 2 —

Wash Down — Closet —



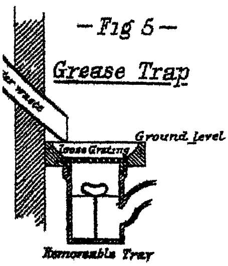
— Fig 3 —

Wash Out Closet



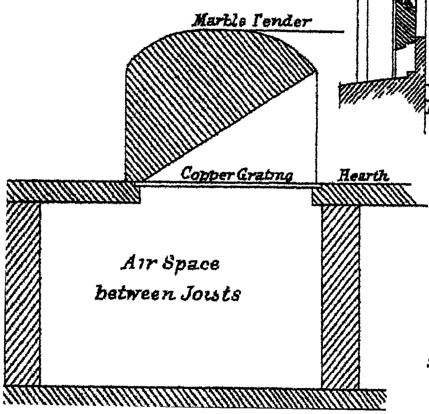
— Fig 5 —

Grease Trap



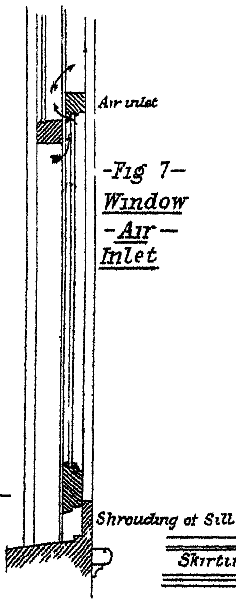
— Fig 6 —

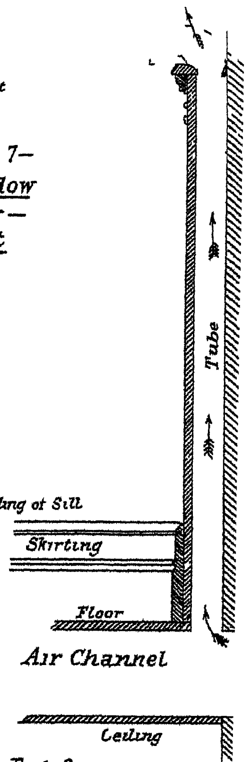
Fender Air Inlet



— Fig 7 —

Window — Air — Inlet





— Fig 8 —

Tobin Tube

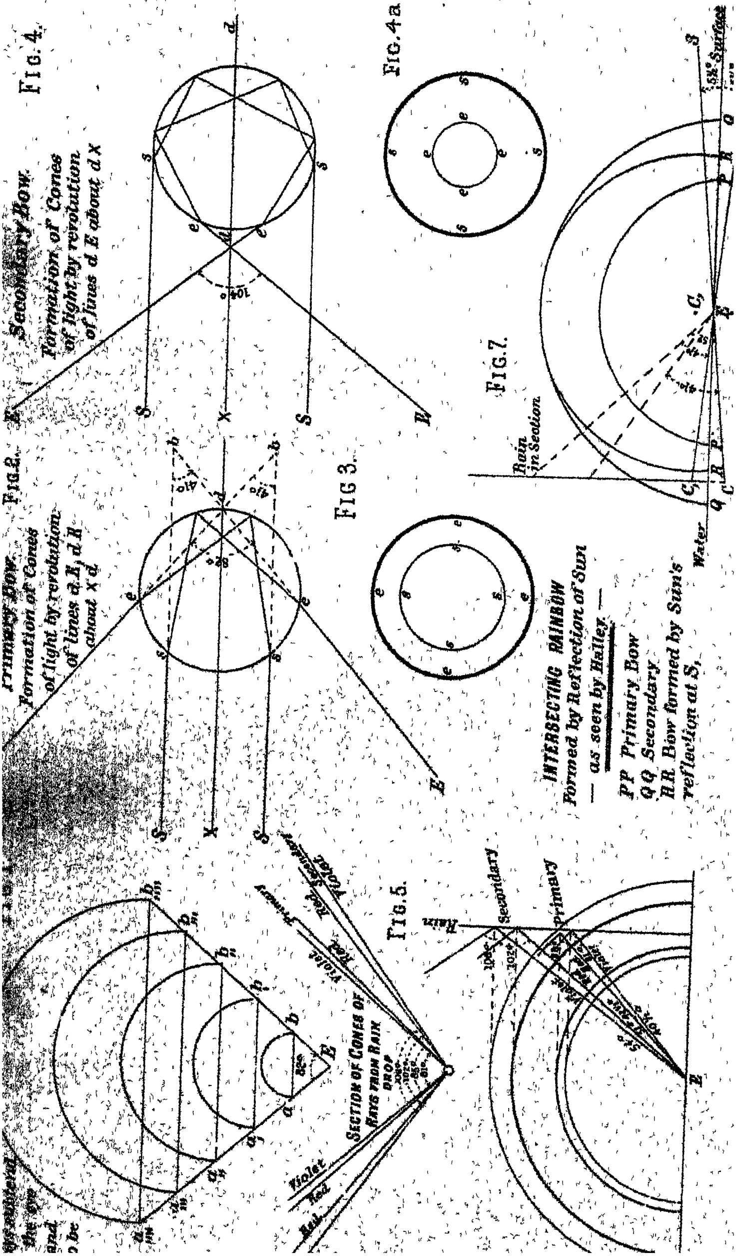


FIG. 4.
Secondary Bow.
Formation of Cones of light by revolution of lines d E about d X
FIG. 4 a
FIG. 2.
Primary Bow.
Formation of Cones of light by revolution of lines d E, d R about X d
FIG 3.
FIG. 7.
Rain in Section
Water
Surface
INTERSECTING RAINBOW
Formed by Reflection of Sun
— as seen by Halley —
PP Primary Bow
QQ Secondary
RR Bow formed by Sun's reflection at S,
FIG. 5.
SECTION OF CONES OF RAYS FROM RAIN DROP
Violet
Red
Secondary
Primary
Rain

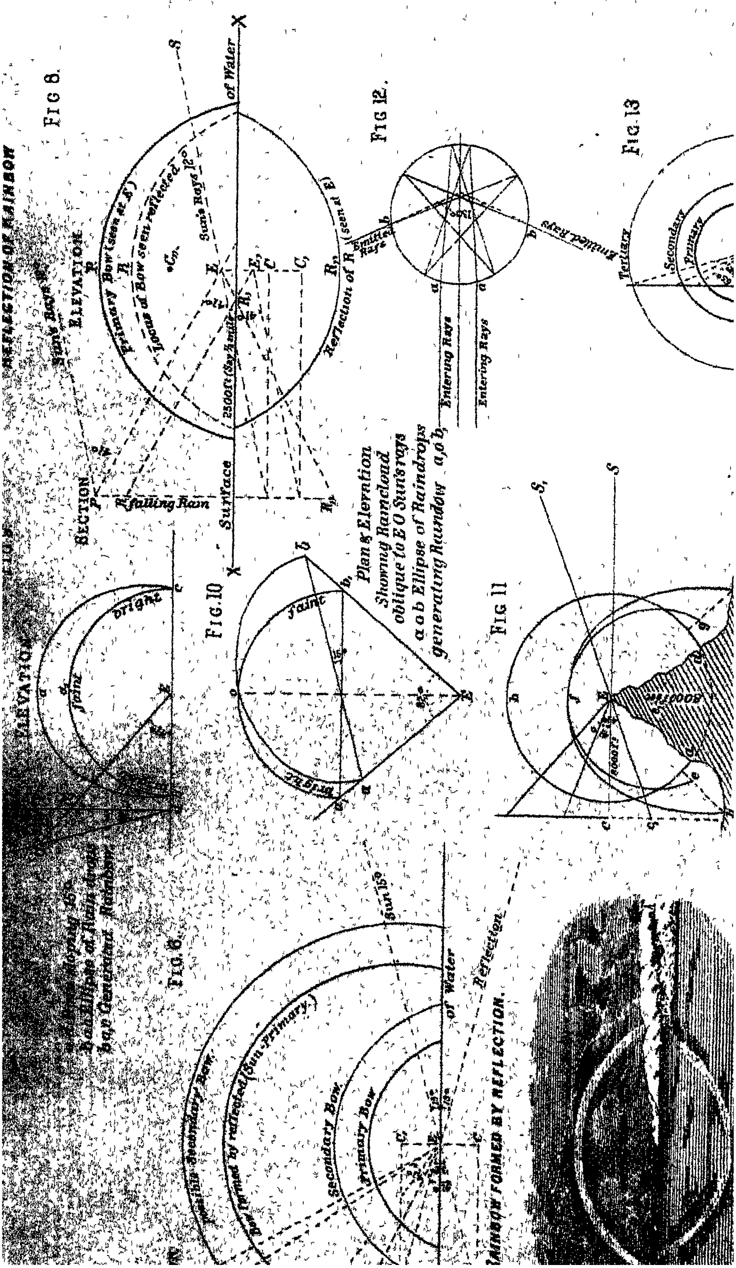
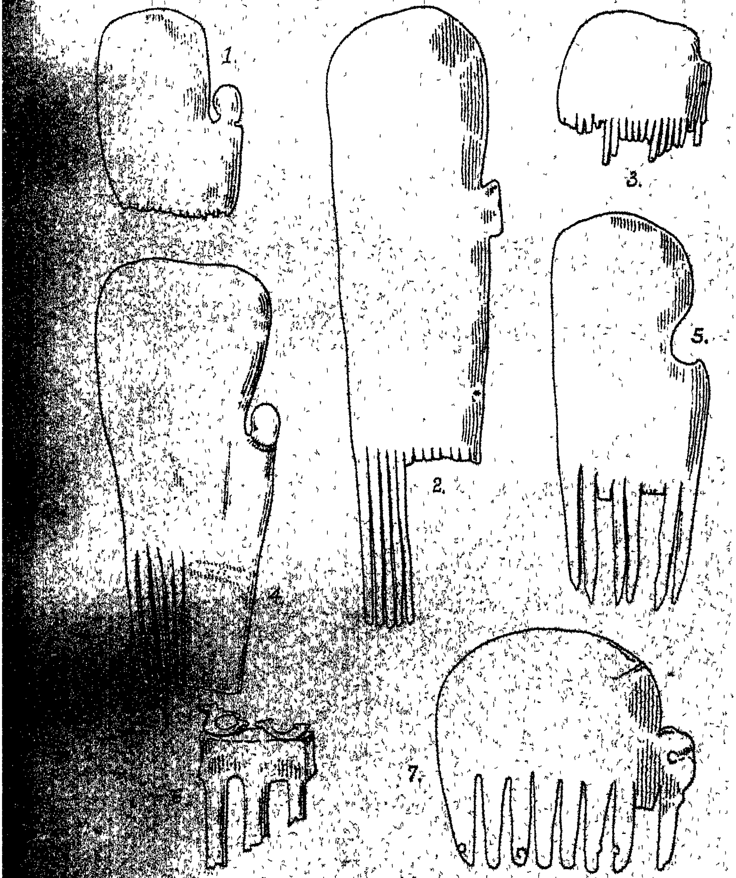


Fig 8.
Fig 12.
Fig 13
Fig. 10
Fig 11
Fig. 6.
Reflection of Rainbow
Elevation
Section
Surface of Water
falling Rain
Primary Bow
Locus of Bow seen reflected
Sun's Rays
Reflection of R
Emitted Rays
Entering Rays
Tertiary
Secondary
Primary
Plan & Elevation
Showing Raincloud
oblique to E O Sun's rays
a o b Ellipse of Raindrops
generating Rainbow a,o,b,
faint
bright
Secondary Bow
Primary Bow
of Water
Reflection
Sun 15°
Rainbow formed by reflection.

Transactions New Zealand Institute, Vol. XXV., Pl. LII.

To illustrate Papers by A. Hamilton



Maori Head Combs.—Bone.

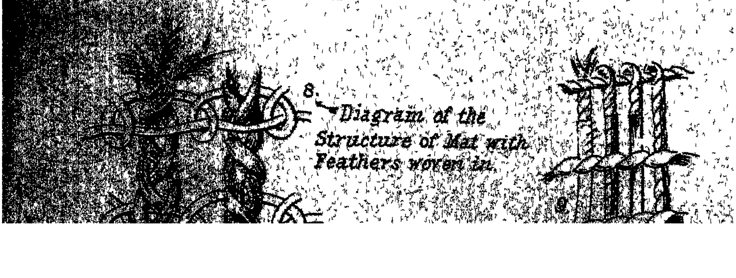
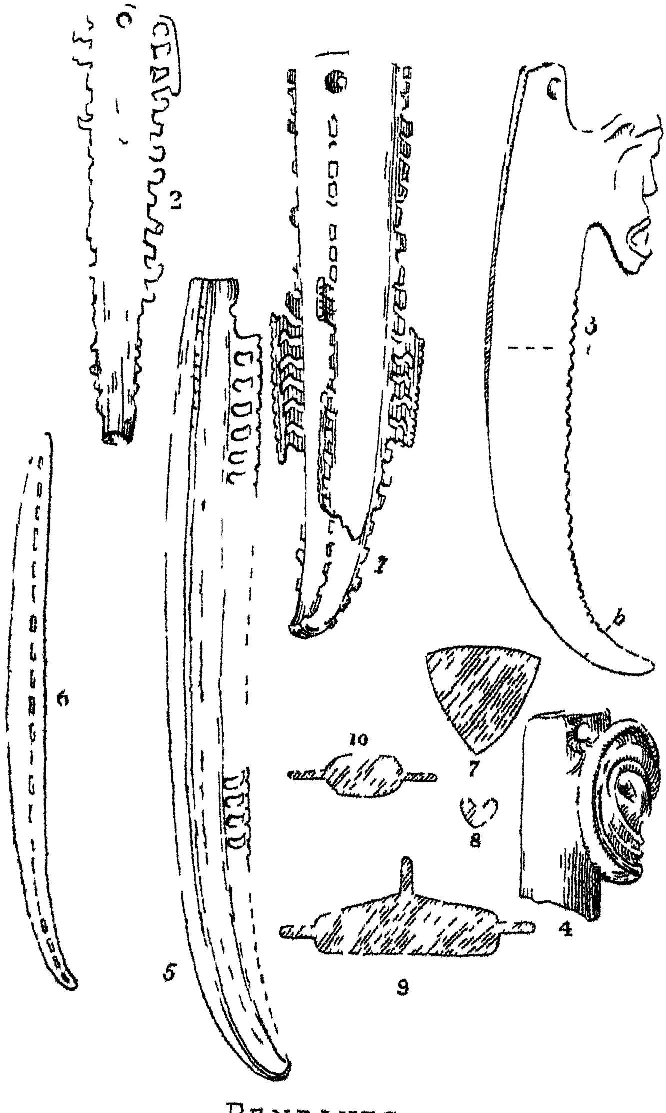
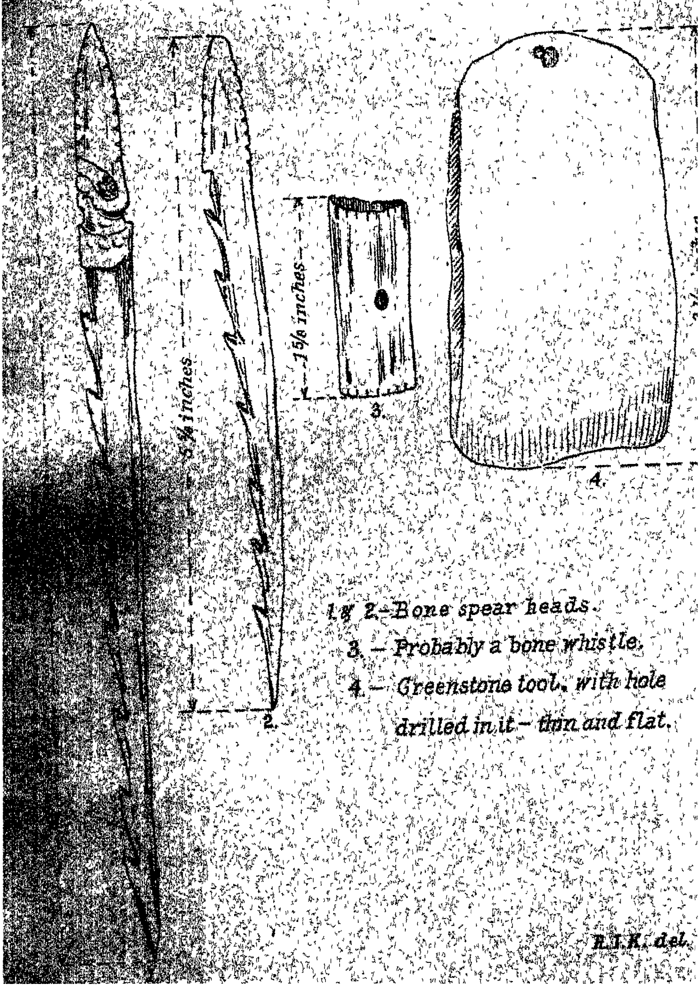


Diagram of the Structure of Mat with Feathers woven in.



PENDANTS

ANCIENT MAORI IMPLEMENTS
— found at Takaka —
To illustrate Paper of R. I. Kingsley Esq.re



MAORI MELODY.